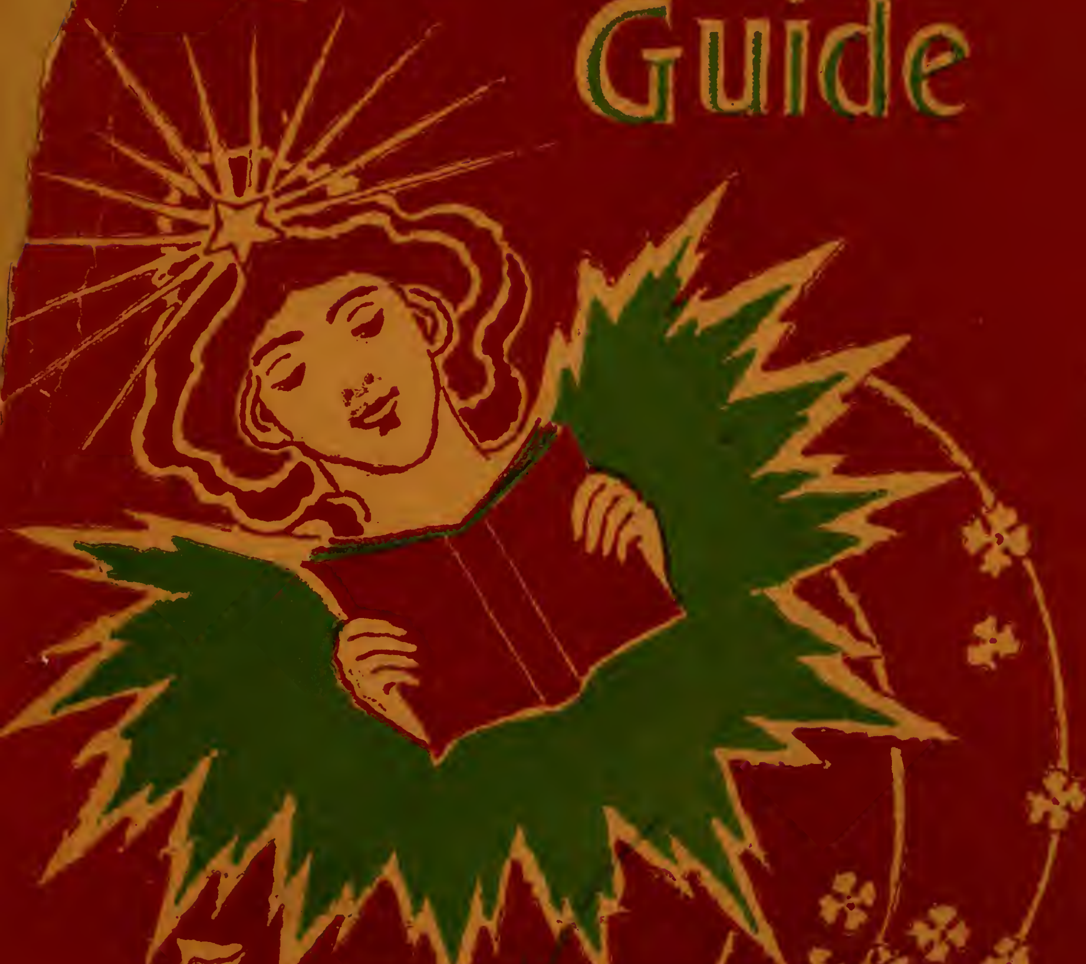
Housekeepers Educator and Guide



Elisha B. Worrell

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THE HOUSEKEEPERS'

EDUCATOR AND GUIDE.

A TREATISE ON FOOD AND ITS RELATION
TO THE HUMAN BODY.

ELISHA B. WORRELL.

DORCHESTER, MASS.
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PREFACE.

I FIND that the people, everywhere, are interested in the subject of food.

During the last ten years, in the hundreds of addresses which I have given in New England, the Middle States, in the West and South, audiences that on many questions would have voiced a notable contrast of opinion, on the value and imperativeness of this question, were practically agreed.

A knowledge of the close relation existing between one's food and every function of the body and brain, is not now limited to physicians and a few special students in dietetics, but is becoming a matter of general interest and discussion in all progressive communities.

Never, perhaps, in the history of the world, were so many people intelligently considering the question of right eating, as now.

When we realize that it is the food taken into the stomach, which, broken and dissolved by digestion, becomes blood, brain, muscle, and by the marvelous chemistry of nature is transmuted into thought, emotion, energy — life itself, the wonder is that these vitally important subjects of diet and nutrition have not always been as prominent as they are today.

With the hope of arousing even new interest in the subject, by putting in terse and comprehensive form some

of its great truths, this book is published. That its study may prove beneficial in the home and family life of the people, so far as its circulation shall extend, is the sincere wish of the author.

Acknowledgment is hereby made of assistance from the following sources, in the preparation of this work:

"Food," by Prof. A. H. Church; "Food in Health and Disease," by I. Burney Yeo, M. D.; "Chemistry of Common Life," by James F. W. Johnston, M. D, and Prof. A. H. Church. "A Treatise on Food and Dietetics," by Dr. F. W. Pavy, and E. B. Worrell's work on "Food Adulteration."

E. B. W.

DORCHESTER, MASS.,
October 7, 1897.

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DEFINITIONS.

ALIMENTARY PRINCIPLES. — 1. In analyzing a food, the several definite compounds found therein, are termed alimentary principles. 2. Some one alimentary principle of several foods, may be, in character, very similar, hence classed together; viz.: the albumen of the egg and the gluten of wheat are both termed Albuminates, and may replace one another in nutrition. "Albuminates" is the name of a group of *alimentary principles* distinguished by the presence of nitrogen.

METABOLISM. — A word used to express the utilization of the food received into the body. In short, the process of *assimilation*.

OXIDATION. — Burning.

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COMPOUNDS AND ELEMENTS OF THE BODY.

The human body is composed of blood, bone, flesh, skin and other materials.

Each of these individual portions, whether of the solids or liquids, is made up of a variety of substances, called *chemical compounds*. These compounds are very numerous, about twenty having been discovered in the brain, alone.

In the following list, only those which are most abundant or best known, are given.

The table is compiled on this basis — a man in good health, thirty years of age, five feet eight inches in height, and weighing one hundred and fifty-four pounds.

COMPOUNDS OF THE HUMAN BODY.

		lb.	oz.	gr.
1.	WATER: which is found in every tissue and secretion, and amounts altogether to	109	0	0
2.	ALBUMEN, MYOSIN, and similar substances, forming the chief organic material of muscular flesh, and also occurring in chyle, lymph, and blood	16	8	0
3.	PHOSPHATE OF LIME: in all tissues and liquids, but chiefly in the bones and teeth.	8	12	0
4.	FAT: a mixture of three chemical compounds; distributed throughout the body	4	8	0
5.	OSSEIN or COLLAGEN: the organic framework of bones and the chief constituent of connective tissue; it yields gelatin when boiled	4	7	350
6.	KERATIN, with other similar nitrogenous compounds, forms the chief part of the skin, epidermis, hair, and nails, and weighs about	4	2	0

		lb.	oz.	gr.
7.	CARTILAGIN or CHONDRIGEN: a nitrogenous substance, is the chief constituent of cartilages; it resembles the ossein of bone, and amounts to	1	8	0
8.	HÆMOGLOBIN, a very important nitrogenous substance containing iron; it gives the red color to the blood, and amounts to . . .	1	8	0
9.	CARBONATE OF LIME is found chiefly in bone . . .	1	0	350
10.	NEURIN, with lecithin, cerebrin, and several other nitrogenized, sulphurized, or phosphorized compounds, is found in brain, nerves, etc.	0	13	0
11.	FLUORIDE OF CALCIUM is found chiefly in bones and teeth	0	7	175
12.	PHOSPHATE OF MAGNESIA, chiefly in bones and teeth	0	7	0
13.	CHLORIDE OF SODIUM, or common salt, occurs throughout the body	0	7	0
14.	CHOLESTERIN, INOSITE, and GLYCOGEN are compounds containing carbon, hydrogen, and oxygen, found in brain, muscle, and liver .	0	3	0
15.	SULPHATE, PHOSPHATE, and ORGANIC SALTS OF SODIUM are found in all liquids and tissues .	0	2	107
16.	SULPHATE, PHOSPHATE, and CHLORIDE OF POTASSIUM are found in all tissues and liquids .	0	1	300
17.	SILICA, occurs in hair, skin, and bone	0	0	30
		154	0	0

Into the formation of these compounds, enter two, three or more distinct kinds of matter, termed *elements*. To illustrate:

No. 1, Water, is a compound of two elements, hydrogen and oxygen.

No. 2, Albumen, is a compound of carbon, hydrogen, oxygen, nitrogen and sulphur.

No. 3, Phosphate of Lime, is a compound of calcium, phosphorus and oxygen.

The number of elements which contribute to the building up of these various compounds is sixteen, all of which are invariably found in the human body.

We now enumerate them, also giving the character and office of each.

ELEMENTS OF THE HUMAN BODY.

		lb.	oz.	gr.
1.	OXYGEN: a gas, the great supporter of combustion. This gas constitutes eight-ninths of the weight of water and more than one-fifth of the air. The quantity in the human body (most of which is combined with hydrogen in the form of water) would fill a space of some 1,290 cubic feet, and would weigh about	109	0	335
2.	CARBON: a solid, occurs nearly pure in charcoal. The carbon in the body is variously combined with other elements, and by its burning sets free heat, and produces carbonic acid gas,	18	10	150
3.	HYDROGEN: a gas and the lightest substance known. It occurs mainly in water; the quantity in the human body would fill a space of some 2,690 cubic feet, and would weigh about .	14	3	150
4.	NITROGEN: a gas without energetic properties. It is an essential part of all bone, and blood, and muscle. The quantity in the body would occupy about sixty-six cubic feet, and would weigh about	4	14	0
5.	PHOSPHORUS: a solid. It occurs specially in various compounds of the bones and of the brain. It burns so readily in air, that it must be kept under water. In the human body we find about	1	12	25
6.	SULPHUR: a yellow combustible solid, often called *brimstone*. Like all the preceding elements, it is found in all the tissues and secretions of the body, but always in combination. It amounts to	0	8	0
7.	CHLORINE: a greenish-yellow corrosive gas, found in the body chiefly in union with sodium, the compound being common salt. The chlorine in the human body would, if free, fill a space of one cubic foot and 772 cubic inches, and would weigh	0	4	150

	lb.	oz.	gr.
8. FLUORINE: a gas with a chemical activity exceeding even that of chlorine. It is found united with calcium in the bones and teeth. The quantity in the body would fill a space of two cubic feet and 510 cubic inches. It would weigh	0	3	300
9. SILICON: a non-metallic solid, occurring in union with oxygen, in hair, bones, blood, bile, saliva, and skin	0	0	14
10. CALCIUM: a metal, the basis of lime. It occurs chiefly in bones and teeth	3	13	190
11. POTASSIUM: a metal, the basis of potash. It is lighter than water, and when placed on it burns with a lilac flame. It occurs mainly as phosphate and chloride	0	3	340
12. SODIUM: a metal, the basis of soda. It is lighter than water, and must be kept from the air. It occurs chiefly in union with chlorine as common salt, but also in other compounds in bile	0	3	217
13. MAGNESIUM: this metal is found, in union with phosphoric acid, mainly in bones	0	2	250
14. IRON: this metal is essential to the coloring matter of the blood. It occurs everywhere in the body	0	0	65
15. MANGANESE: a metal much like iron. Faint traces occur in the brain, and decided traces in the blood.			
16. COPPER: traces of this metal are invariably found in the human brain, and probably also in the blood.			

These elements (in compounds) are supplied to the body, by the water drank, the air absorbed in breathing and by the food which is eaten.

To maintain life, perfectly, the water and air must be both fresh and pure, and the food so varied as to contain, essentially, the same compounds as constitute the formation of the body.

THE FOUR ALIMENTARY PRINCIPLES.

To study the subject most advantageously, let us consider the four groups into which food has been divided, known as alimentary principles.

GROUP NO. I.

This comprises the chief *nitrogenous* alimentary principles and may be termed *albuminates* (albumen being taken as the typical member of the group).

The chief of these nitrogenous alimentary principles are:

Blood fibrin.
Syntonin, or muscle fibrin.
Myosin, from muscle.
Albumen in its various forms.
Vegetable fibrin, or *Gluten*.
Casein, animal and vegetable, the latter sometimes termed *Legumin*.
Globulin, occurring in the contents of the blood corpuscles.

The members of this class present a remarkable uniformity of chemical composition, and can replace one another in nutrition. They contain from 15·9 to 16·5 per cent of nitrogen; their other elements being carbon, hydrogen, oxygen, and sulphur, or phosphorus.

Gelatin, though referred to later on as one of the subordinate nitrogenous substances, is nevertheless very rich in nitrogen. It is an *albumen-sparing* food, and, except for the purposes of building-up and repairing the tissues, can suitably, and to a limited extent, take the place of albuminates in nutrition.

GROUP NO. 2.

The *fats*, or *hydrocarbons*, consist of the various animal and vegetable fats, oils, wax, etc. These resemble one another in chemical composition, and are especially rich in carbon, their percentage composition being represented by the following figures :

Carbon	79
Hydrogen	11
Oxygen	10

They differ somewhat in their physical state, some being solid and hard, like wax; others softer, like butter; others quite fluid, as certain oils. They vary also in their digestibility, and therefore in their value as foods.

GROUP NO. 3.

This third class comprises all the *starchy* and *saccharine* substances used as food, and these are termed *carbohydrates* from their chemical composition, in which hydrogen and oxygen exist in the proportions to form water.

GROUP NO. 4.

This includes *water* and the various *mineral substances* which occur in the animal body.

These four groups of alimentary principles comprise all that is necessary for the growth, maintenance, and activities of the animal body.

In addition, however, to these four groups, may be mentioned the various substances termed *food accessories*, comprising the several condiments which give flavor to food, or stimulate the digestive secretions, and the well-known "stimlant" and "food" beverages, tea, coffee and cocoa.

Foods have also been classified into *organic*, those derived from the animal and vegetable kingdoms, and *inorganic*, namely, mineral substances or salts; also into *nitrogenous*, those containing the element nitrogen, and *non-nitrogenous*, those containing no nitrogen.

Arranged in tabular form, these various classifications may be thus represented:

ORGANIC.

NITROGENOUS.

1. **Albuminates**—Nitrogenous substances, having the same or nearly the same chemical composition as Albumen. *Examples.*—Albumen, Fibrin, Syntonin, Myosin, Globulin, Casein, from the *Animal;* Gluten and Legumin, from the *Vegetable* Kingdom.

   (*a*) *Subordinate* nitrogenous substances referred to this class, and known as—

   Gelatigenous substances { Gelatin. / Chondrin.

NON-NITROGENOUS.

2. **Fats** or **Hydrocarbons,** containing Carbon, Hydrogen, and Oxygen—the proportion of oxygen being insufficient to convert all the hydrogen into water. *Examples.*—Olein, Stearin, Margarin, (Butter is a familiar one).
3. **Carbo-Hydrates,** containing Carbon, Hydrogen and Oxygen, the two latter elements in the proportions to form water. *Examples.*—Starch, Dextrin, Cane Sugar, Grape Sugar, Lactose or Milk Sugar.

   (*a*) The *Vegetable Acids,* Oxalic, Tartaric, Citric, Malic, Acetic and Lactic, are by some authors referred to this class.

INORGANIC.

MINERAL.

4. **Mineral.**

   Water.

   Salts.—Sodium and Potassium Chlorides, Calcium and Magnesium Phosphates, Iron, etc.

We now pass on to the consideration of the uses, in the nutrition and maintenance of the body, of these several groups of alimentary substances.

As the human body is chiefly composed of albuminous or nitrogenous substances, and as the various functions of the body are mainly concerned with the physical and chemical changes these undergo, we find that the *albuminates,* or the nitrogen-containing group of foods, plays a very important part in its nutrition, and in the development and maintenance of its energies.

Two functions of the albuminates, are:

1st, They contribute to the formation and repair of the tissues and fluids of the body, and in an especial manner of the nitrogenous tissues.

2nd, They regulate the absorption and utilization of oxygen, and so play a very important part in the chemistry of nutrition.

We might here state, that on general principles, animal foods are richer in nitrogenous matter, than vegetable foods.

Next we must consider the purposes served by the *fats* or *hydrocarbons* in nutrition.

A proper use of fat economizes the albuminous elements of food and checks the waste of the albuminous tissues. Fat enters into all the tissues. By its decomposition and oxidation it yields muscular force and heat, and it is therefore largely consumed in muscular exercise. By its capacity of being stored up in the body as adipose tissue, it provides a reserve store of force-producing and heat-generating material which can be utilized as required.

One of the great purposes served by fat in the food is to diminish albuminous metabolism, and it is, therefore, regarded as an "albumen-sparing" food. If flesh alone be given, large quantities are required in order that nutrition and waste may balance one another, but if fat be added the demand for flesh is less.

Carbohydrates have much in common with the fats. They serve the same purpose of checking albuminous waste; like them, they are resolved by combustion within the body, ultimately, into carbonic acid and water, and so, like the fats, are capable of yielding heat and mechanical work. Unlike the fats and the albuminates, however, they do not appear to enter into the structure of the tissues, although they are found in some of the fluids and organs of the body.

All the carbohydrates are converted into glucose, or grape

sugar before they are absorbed, and in this form they are much more readily metabolized than the fats or albuminates.

The fourth group comprises *mineral substances* and *water*. These are of great importance, and are as essential to nutrition as the albuminates. There is no tissue that does not contain lime, chiefly in the form of phosphate, and it would seem that cell growth cannot go on without it; indeed, calcium phosphate is the most abundant salt in the body, forming more than one-half our bones. Calcium carbonate occurs associated with this phosphate, but in relatively much smaller quantity. Sodium chloride is also a very important salt, and occurs in all the tissues and fluids of the body.

It is absolutely necessary to existence, and its *entire* withdrawal from food would be speedily fatal. The phosphates of sodium and potassium are also important salts. These and other mineral substances are introduced into the body, as constituent parts of the various articles of human food, animal and vegetable.

Water enters into the composition, in greater or less proportion, of most solid and all fluid foods, and it is the essential basis of all beverages. It forms 58·5 per cent of the human body, from which it is continually passing off by the urine and fæces, and by the skin and lungs. Water is essentially requisite in the processes of digestion and absorption as a solvent for food substances, and it is also required for the solution of the various substances which have to be removed from the body in the excretions, especially in the urine. Indeed, there is no vital action possible without water. The amount of water needed by the body depends on various circumstances, especially on bodily temperature and bodily labor. The need of the organism for water is usually indicated, when in health, by the sensation of thirst. An insufficient supply of water leads to disturbances in the circulation, and in the distribution of heat, and to the retention in the body of the waste products of metabolism.

ANIMAL FOOD.

Animal foods have certain decided advantages. In the first place, they contain the same chemical elements as the bodies they are destined to feed. They are very rich in albuminous or nitrogenous substances, combined with a certain amount of fat; they are more easily and completely digested and assimilated than vegetable foods; they are easily cooked, and develop agreeable flavors in the process; and they contain important salts (chiefly salts of potassium) and some iron.

Animal foods are therefore exceedingly well adapted to minister to the growth and maintenance of the organic structure of the body; their disadvantage is the absence of starch, so that they are not so well adapted as non-nitrogenous substances for the production of force. When, however, there is a mixture of a considerable proportion of fat with the muscle tissue, this disadvantage is greatly lessened.

Animal flesh differs considerably in flavor, in digestibility, and in nutritive qualities, according to age, sex, state of nutrition, part of the body, etc. Meat containing much fat is generally less digestible and less palatable than leaner varieties.

The flesh of young animals is less digestible than that of more mature ones; veal and lamb are less digestible than beef and mutton; and in advanced age the flesh becomes tough and uneatable. There is less flavor, less stimulating

properties, less nutritive value in the tissues of young animals than in mature ones. A four or five year-old ox yields the best beef, and a three year-old sheep the best mutton.

Animal food is comprised of meat, poultry, game, fish, eggs, milk, etc.

We will enumerate a few of the principal animal foods:

BEEF.—This is, perhaps, the most extensively consumed and most nutritious of all animal foods.

The flesh varies also in quality, according to the part of the animal from which it is taken. The best, or first quality, includes rump, sirloin, fore-ribs; the second, a portion of shoulder, buttock, middle-rib, etc.; the third, flank, shoulder, brisket; and the fourth, cheek, neck, and shin.

VEAL.—Veal has the reputation of being less digestible and less nutritious than beef or mutton.

MUTTON.—Mutton is generally considered to be more easy of digestion than beef. Its fibre is shorter and more tender. It often, however, contains a large proportion of fat, which is harder than beef fat. Such fat mutton is unsuited to invalids.

Mutton, however, differs very greatly in quality and flavor; when of best quality, it is no doubt a most excellent form of animal food.

PORK.—Pork, on account of the large quantity of fat it contains, is the most difficult of meats to digest. Like all fat meats, it contains proportionately less water.

CONSTITUENTS IN 100 PARTS OF

	Beef, well-fed.	Beef. fat.	Veal.	Pork, lean.	Pork, fat.	Mutton.
Water - -	69·4	55·0	61·8	71·1	44·5	70·8
Nitrogenous matter	19·5	16·5	18·2	20·8	12·6	19·0
Fat, etc. - -	9·7	27·3	8·9	6·9	42·4	9·0
Mineral matter -	1·4	1·2	1·1	1·2	0·5	1·2

LAMB, like veal, is less digestible than mutton, and is very much richer in fat.

Bacon is more digestible than the fat of fresh pork. It contains but a small proportion of water, and therefore, weight for weight, is an advantageous kind of food. Its popular use, like that also of boiled pork, with lean meats such as veal, chicken, and rabbit, and also with other articles rich in nitrogenous matter, as eggs, beans and peas, is founded upon a rational principle, serving, as it does, to establish a proper proportion in the supply of nitrogenous and carbonaceous material.

Venison.— Vension from young deer is tender, short-fibred, dark-colored and highly savory, and is very digestible. It is, however, rather too stimulating and highly flavored for delicate stomachs.

The various processes of cooking meat influence its composition and digestibility differently.

If meat be boiled, it should be plunged in boiling water for a few minutes, and then such an amount of cold water added as will suffice to lower the heat of the water to about 170° F., which temperature should not be much exceeded during the whole time of cooking. Meat looses considerably both in digestibility and flavor when twice cooked.

The general tendency of the process of roasting meat is to render it more palatable and more concentrated, but at the same time to reduce the proportion of fat. But cooking generally lessens the rate at which meat is digested; this is evident from the figures in the following table of the

TIMES OF DIGESTION OF

	Hours.		Hours.
Beef, raw	2	Mutton, roasted	3¼
Beef, half-boiled	2½	Veal, raw	2½
Beef, well-boiled	2¾ to 3	Pork, raw	3
Beef, half-roasted	2¾ to 3	Pork, roasted	5¼
Beef, well-roasted	3¼ to 4	Fowls, boiled	4
Mutton, raw	2	Turkey, boiled	2½
Mutton, boiled	3	Venison, broiled	1½

Poultry and Game.—The various kinds of poultry, game, and wild fowl are favorite forms of food, and some of them are especially serviceable to invalids and persons of feeble digestion. Their flesh differs from that of ruminating mammals, in not having its muscular fibres permeated by fat, and it is also short-fibred, and therefore more easily disintegrated. Those with white flesh, as the fowl and turkey amongst poultry, and the partridge amongst game, are especially tender, delicate in flavor, and easy of digestion; but the flesh of ducks and geese is dark-colored, harder, richer, with a stronger flavor, and is much more difficult of digestion.

The flesh of Game contains less fat than that of poultry, and has a finer flavor. It is tender and easy of digestion. Keeping develops the flavor of game, and is especially notable in grouse. The absence of fat and the finer flavor will often commend it to invalids in preference to poultry. Snipe, quail, and woodcock are delicate in flavor, but they are too rich for invalids. Game for invalids should only be kept long enough to secure tenderness, and the breast is the most suitable part for them to eat. Wild fowl generally have close and firm flesh, of strong and often fishy flavor, not suited to the digestion of invalids.

The flesh of a young Hare is short-fibred, very tender, and of excellent flavor; it is nearly as digestible as chicken, but more stimulating.

The flesh of the Rabbit when young is fairly digestible, but when older it becomes dry and hard in cooking, and cannot be said to be easy of digestion.

Fish.—Fish afford a large and important part of human food. The different kinds vary greatly in nutritive value, in edible quality, and in digestibility. The relative proportions of fat they contain are especially subject to variation, and this determines greatly their flavor and their facility of digestion.

Of the great nutritive value of fish no doubt can exist, and whole populations exist entirely upon it.

Fish is considered to be less satisfying and less stimulating than the flesh of birds and mammals; it appears to be digested more rapidly, and therefore requires to be taken at shorter intervals or in larger quantity. For these reasons it forms an especially useful food for invalids whose digestive powers are unequal to cope with the stronger kinds of animal food.

White-fleshed fish contain very little fat. Amongst the fish having white flesh are the whiting, haddock, cod, sole, turbot, flounder, etc.

The flesh of the salmon particularly presents a strong contrast in color to that of the fish above enumerated. It approaches meat in redness, and is regarded as approaching it also more closely than any other fish in sustaining properties.

The herring, and mackerel, as well as the eel, contain much fat mixed with their flesh, and these fish are, on that account, unsuited to persons with delicate digestions.

The flounder, like the sole and whiting, is light and easy of digestion, and has a delicate flavor if cooked very fresh. Cod and haddock are not very easy of digestion; the former varying greatly in quality, and sometimes being hard and tough.

The fat existing in the animal is especially accumulated in the liver, and in the cod-fish particularly, when in season, the liver is enormously gorged with oil.

COMPOSITION OF FISH (Edible portion — In 100 parts).

	Mackerel.	Salmon.	Flounder.	Eel.	Herring.
Water	72·5	64·0	80·4	61·0	80·0
Nitrogenous matter . .	17·5	22·0	14·0	10.8	10·9
Fat	8·0	12·2	2·0	27·2	7·1
Mineral matter	2·0	1·8	3·6	1·0	2·0

Louis Agassiz spoke of fish as a food "refreshing to the

organism, especially after intellectual labor; not that its use can turn an idiot into a wise or witty man, but a fish diet cannot be otherwise than favorable to brain development."

The Oyster, when in season and eaten raw, is esteemed a very digestible form of food; but when cooked, it is by no means easy of digestion.

The flesh of the lobster is more delicate and more digestible than that of the crab, and is usually much preferred to it. They both suffer decomposition rapidly, especially in hot weather, and should therefore be eaten quite fresh.

Milk and its Derivatives—Cream, Butter and Cheese. It will be necessary to consider at some length the properties of that very important animal food — milk — a food which is remarkable as containing all the alimentary substances required for the support and maintenance of animal life, and which is, on that account, termed a *complete* or typical food. The only other *complete* food afforded by the animal kingdom is eggs.

Not only does milk form the exclusive food, for a time, of the young of all the mammalia, but it is also capable of being advantageously employed as the chief food for adults under various circumstances.

In milk we find the four classes of alimentary substances necessary for health combined in proportions well adapted for the period during which growth is active; but when applied to the feeding of adults, the proportion of albuminates and fat are in excess as compared with the amount of sugar.

The chief constituents of milk — whether cow's milk, human milk, goat's milk, or the secretion of other mammals — are casein and albumen, lactose or sugar of milk, milk-fat, and phosphates: a small quantity of citric acid, or about 0·1 per cent, seems to be generally present in the form of a lime salt; milk also contains a small quantity of dissolved carbonic acid gas. Cow's milk, from a herd of healthy animals, properly fed, presents a remarkable uniformity of composition.

But morning milk will often be poorer in total solids than evening milk; and milk from cows pastured upon poor and overstocked land will be poor in quality and reduced in quantity; milk drawn last from the udder—the "strippings"—will be richest, especially in cream, and consequently in milk-fat or butter. The following may be taken as the average composition of cows' milk:

	In 100 parts.
Water	87·0
Casein, albumen, and lacto-protein	3·4
Milk-fat	3·8
Lactose, or milk-sugar	5·0
Mineral matter	0·8

Cream.—Cream consists mainly of the fatty matter of milk, which, by virtue of its lightness, rises to the surface, the milk being allowed to repose for some time for the purpose. It contains some of the watery liquid part of the milk which holds in solution the other constituents. The composition of cream will necessarily vary a great deal according to its purity, or the manner in which its collection by skimming is effected.

Butter.—Butter is the fatty portion of milk, and is obtained by the process of churning, either cream or the milk itself being subjected to the operation. The effect of churning is to cause the milk-globules to run together or coalesce, and thus to become incorporated into a solid mass. Butter is one of the most digestible of animal fats, and one of the most agreeable and most delicate in flavor.

Cheese.—Cheese is composed of the casein or curd of milk, together with a variable amount of the fat of milk, according to the manner in which it is prepared.

The milk is usually coagulated by the addition of rennet, and a certain amount of salt, five or six per cent, is added. The fat globules are entangled in the coagulated casein.

The curd, after coagulation, is subject to pressure, in order to express as much of the retained fluids, milk and whey, as possible. It is placed in moulds for a time to consolidate, and subsequently it is removed and ranged on shelves in a cool situation, where it remains for some time to *ripen*. In this *ripening* process the fats increase at the expense of the casein, and volatile fatty acids are developed, which impart to the cheese its characteristic odor and flavor. The richer the cheese in fat, the more highly flavored it is capable of becoming.

Cheese is an exceedingly valuable, nutritive and economical food on account of the large proportion of nitrogenous substances it contains — twice as much, weight for weight, as meat ; it is also agreeable to the palate. Cheese with bread forms a popular, convenient and highly nutritious diet.

Cheese is popularly regarded as a food difficult of digestion, but this has, doubtless, been much exaggerated. The poorer, harder kinds of cheese, which contain a large proportion of casein, are certainly difficult to digest, but the richer, softer, finer-flavored and less compact cheeses by no means merit this reproach, and, in small quantity, exercise a stimulant action on the stomach.

EGGS. — Eggs form another *complete* food, like milk. They contain all the elements of the blood.

The egg of the domestic fowl is the one chiefly utilized for human food, but eggs of the duck, goose, turkey and guinea-fowl are occasionally eaten. Plover's eggs are greatly esteemed for their delicacy of flavor. The eggs of all birds have the same composition, and are suitable for food, but their quality and flavor depend greatly on the food of the bird which yields them.

The mineral matter of hens' eggs, though small in quantity, is rich in quality, consisting, as it does, mainly of phosphates of lime, potash, soda, magnesia, and iron.

Eggs are very nutritious articles of food. They contain more albuminoids but rather less fat than an equal weight of beef.

	White of Egg.	Yolk.
Water	84·8	51·5
Albuminates	12·0	15·0
Fats, etc.	2·0	30·0
Mineral Matter	1·2	1·4
Pigment Extractives	——	2·1

It is here seen that the *yolk* differs from the white chiefly in its greater richness in solids, especially in fats, and in the presence of pigment. The saline constituents are the same as those found in the blood; the *white* has an excess of chlorides, the *yolk* an excess of phosphates.

The *yolk* is of more importance than the *white* from an alimentary point of view, as it contains a quantity of fat as well as a peculiar form of albumen, whereas the *white* is chiefly a simple solution of albumen. In some persons certainly, if not in all, white of egg, if taken uncooked in large quantities, give rise to albuminuria, but the slightest amount of cooking will usually prevent this.

Raw and lightly boiled eggs are easy of digestion. The hard-boiled egg offers considerable resistance to gastric solution, and exerts a constipating action on the bowels.

VEGETABLE FOOD.

We derive from the vegetable kingdom a great variety of foods, many of them of a highly nutritious character, and therefore of great importance to the human race.

The foods obtained from the vegetable kingdom, like those derived from the animal world, contain both albumen and fat, but, as a rule, in vegetable foods the non-nitrogenous constituents are greatly in excess of the nitrogenous ones, and occur chiefly as carbohydrates; and, save in the case of certain fruits and seeds, they contain but little fat.

Vegetable foods differ further from animal foods in being less digestible and less capable of complete assimilation by the digestive organs of man.

Vegetable foods are, as a rule, particularly rich in carbohydrates. Of these *starch* is the most important. It abounds in all plants and seeds and in the potato and other tubers.

Cellulose, which exists in abundance in all plants, is closely allied to starch, but it is only capable of serving as human food when quite young and tender. It tends quickly to become "woody," and is then not only itself incapable of digestion by man, but hinders the digestion of the other constituents associated with it.

The different kinds of sugar are important *carbohydrates*, found also in many vegetables. They are not only nutritious in themselves, but they are most valuable from the property they possess of giving an agreeable flavor to other foods.

CEREALS.—The cereals are, of all the products of the vegetable kingdom, those best adapted for the food of the human race, and we accordingly find them almost universally spread over the surface of the globe. They contain a large quantity of nutritious substances condensed into a small space, and they are, therefore, convenient both for storage and transportation, and being dry they can be preserved for a long period without deterioration.

They are rich in nitrogenous substances, the various grains containing from five to fourteen per cent; rich also in starch and cellulose, and they contain small and varying amounts of gum, sugar, and fat.

They also contain a considerable proportion of mineral substances, chiefly in the form of phosphates of lime, magnesia, potash, and soda, together with small amounts of iron and silica.

	Nitrogenous Substances.	Fat.	Starch Sugar, Gum, etc.	Cellulose.	Ash.	Water.
Wheat .	12·42	1·70	67·89	2·66	1·79	13·56
Rye . .	11·43	1·71	67·83	2·01	1·77	15 26
Barley .	11·16	2·12	65·51	4·80	2 63	13·78
Oats . .	11·73	6·04	55·43	10·83	3·05	12·72
Corn .	10·05	4·76	66·78	2·84	1·69	13·88
Rice . .	7·81	0·69	76·40	0·78	1·09	13·23

Oats, it will be seen, are especially rich in fatty and mineral substances, and also in cellulose. Corn also is relatively rich in fat, but slightly deficient in salts. Barley contains more fat, more cellulose, and more salts than wheat, but less nitrogenous substances and less carbohydrates. Rice is seen to be rich in starch, but defective in nitrogenous and, indeed, in all the other solid constituents.

WHEAT.—Of all the various cereal grains commonly used

as food, wheat is the most largely consumed and most extensively cultivated. It is rich in solids, and contains but little water; it therefore presents much nutriment in small bulk. It yields a finer flour than other grains, and the proportion of nitrogenous substances contained in it is large. These consist of soluble albumen and gluten. Gluten really consists of four nitrogenous substances, which have been named gluten-casein, gliadin, gluten-fibrin, and mucedin. A nitrogenous substance, termed *cerealin*, regarded by some as merely a form of diastase, is also found in the inner envelope; it is capable of transforming starch into dextrin, sugar, and lactic acid. Wheat contains an abundance of carbohydrates, from sixty to ninety per cent, consisting chiefly of starch, dextrin, and sugar. A small amount of cholesterin is found in wheat. It is rich in phosphates, especially in potassium and magnesium phosphate.

Its chief defects as a food are the small amount of fat (1·7 per cent) it contains, and the absence of those salts of the vegetable acids which are converted in the system into carbonates.

The use of flour made from the whole grain, is now universally advocated. It is very rich in nutritive constituents. The *hard* wheats yield a flour richer in gluten than the soft ones, and therefore more nutritious. The central white part of the grain is particularly rich in starch.

Oats.—Oatmeal is a highly nutritious food. As will be seen by the preceding table, the grain is rich in nitrogenous substances and also in fat. The fine muscular development of the Scottish Highlanders is attributed to their large consumption of oatmeal in childhood. The high nutritive value of oats, as a food for animals that are called upon to give out great muscular activity, is well known. Oatmeal porridge is found to act as a slight laxative with some persons. Owing to the absence of adhesive quality (such as is

possessed by the gluten of wheat) in its nitrogenous constituents, it cannot be made into bread. Oats contain nearly four times as much fat as does wheat.

Rye. — This grain, which has a close resemblance, in outward aspect, to wheat, is white internally, but brown on the outside, so that rye-meal makes a "black" bread. It is equal to wheat in nutritive value, but contains less vegetable fibrin and more casein and albumen. It also contains a peculiar odorous substance, and makes a sour-tasting, dark bread, which often disagrees with persons unaccustomed to its use and causes diarrhœa.

Barley.— The meal of barley is very nutritious. The Greeks and Romans trained their athletes on barley. It is rich in nitrogenous substances, which consist of gluten-casein, gluten-fibrin, mucedin and albumen. It is especially rich in iron and phosphoric acid. It is not so well suited for making bread as wheat flour; the bread is heavier, less digestible, and is said to be rather laxative.

Pearl barley is merely the grain deprived of husk, and rounded and polished.

Barley bread is usually made of a mixture of wheat-flour with barley-meal.

Pearl barley is much used for making barley-water, a slightly nutritious beverage much used in sickness. Barley produces the best malt.

Corn. — Corn is highly nutritious, and most analyses agree in attributing to it the largest proportion of fat of all the cereals; but, as will be noticed, in the preceding table, it comes next to oats in this respect. In the green and succulent state the grains are cooked as a fresh vegetable like peas.

Hominy is a preparation of corn. Owing to its deficiency in gluten, corn-meal is ill adapted for making bread unless mixed with some wheat or rye flour; but it is often made into cakes, which are palatable and nutritious, such as the "hoe-cake" of the south.

On account of the large amount of fat contained in corn it is apt, if kept long, to acquire an unpleasant rancid taste. Corn is used largely for feeding and fattening animals, for which purpose it is especially suitable, because of its richness both in fat and nitrogenous substances.

RICE. — Rice, grown in North and South Carolina, but largely cultivated in the East, and forming the staple food of many oriental peoples, is a grain of much less nutrient value than the preceding. It is comparatively poor in nitrogenous substances, the amount, however, varying considerably in different specimens, from 3 to 7·5 per cent. It is also very poor in fat and in salts; its chief constituent is starch, which exists in rice in a very digestible form. In the prepared state it also contains very little of the indigestible *cellulose*, a circumstance which adds to its value as a food. It bears some analogy in composition to the potato.

Rice is too poor in nitrogenous, fatty and mineral substances to be a suitable food by itself; it would have to be taken in too large quantities, and much of the starch it contains would therefore be wasted. But it is a very valuable food when mixed in proper proportions with other alimentary substances richer in fat and albuminates.

The ready digestibility of its starch granules renders it a very suitable food for persons with an irritable intestinal mucus membrane.

It cannot, by itself, be made into bread, but it is often mixed with wheat flour to make a very white bread. It should not be boiled, but thoroughly *steamed* when cooked by itself, as boiling removes some of the small amount of nitrogenous and saline matters it contains, and so further lessens its food value.

MILLET AND BUCKWHEAT.— The composition of millet is (excluding *cellulose*): Water, 12·3; albuminates, 11·3; fats, 3·6; carbohydrates, 67·3; salts, 2·3. The ash contains

much silica and phosphates. As might be inferred from its composition, it makes a good nutritious bread. The composition of buckwheat meal, is as follows: Water, 14·27; nitrogenous substances, 9·28; fat, 1·89; starch, cellulose, etc., 70·68; ash, 0·86. It makes a fairly nutritious and palatable bread. Cakes made of buckwheat are also popular.

The Pulses or Leguminous Plants. — The ripe seeds, such as beans, peas, and lentils, surpass all other farinaceous seeds in the large amount of nitrogenous substances they contain. This occurs chiefly in the form of vegetable casein or *legumin*, but they also contain, in addition, a little albumen and other proteids, together with much starch. By their richness in albuminates they greatly excel the cereals in actual nutritive constituents. Lentils, for example, contain about double the amount of nitrogenous substances that ordinary wheat does. These leguminous seeds are therefore the best suited by their composition to replace animal food.

Peas and beans contain much sulphur and phosphorus in combination with legumin; they are richer also than the cereal grains in potash and lime, but poorer in phosphoric acid and magnesia.

Owing to the large proportion of albuminates they contain they form a valuable addition to other food stuffs containing much starch or fatty matter; and in combination with rice they form the staple food of many races. Eaten also with animal fat (bacon and beans) they constitute a highly nourishing food. They are especially useful when much exercise is taken; and both men and animals can subsist upon them alone for long periods.

Their defects as compared with the cereals are their relative indigestibility, and their less agreeable taste. About 6·5 per cent of the ingested pea passes out unchanged, and starch cells giving a blue reaction with iodine are found in the fæces.

The following table shows the mean composition of the pulses as compared with that of wheat :

	Water.	Nitrogenous Substances.	Fat.	Starch, etc.	Cellulose.	Ash.
Wheat .	13·56	12·42	1·70	67·89	2·66	1·79
Beans .	13·60	23·12	2·28	53·63	3·84	3·53
Peas . .	14·31	22·63	1·72	53·24	5·45	2 65
Lentils .	12·51	24·81	1·85	54·78	3·58	2·47

Roots and Tubers. — The various roots and tubers employed as food are valuable chiefly on account of the amount of starch they contain; they are vastly inferior in nutritive value to the cereals and pulses, as they contain a relatively large amount of water and a comparatively small proportion of albuminates. Many contain a considerable quantity of sugar as well as starch, and also some *pectin* or vegetable jelly. Some contain vegetable acids, chiefly combined with potash, and these salts give them their well-known and important anti-scorbutic properties.

The Potato.—This tuber, or swollen underground stem of the *Solanum tuberosum*, is the most important of these foods. It is a very productive vegetable, and therefore well repays cultivation, and when cooked, forms a palatable and easily digested food. It is not, however, because of its lack of albuminates, fit to be made the exclusive food of a people.

The average percentage composition of the potato is: Water, 75·77 ; nitrogenous substances, 1·79 ; fat, 0.16 ; starch, 20·56 ; cellulose, 0.75 ; ash, 0.97 ; asparagin and amidic acid are found amongst the nitrogenous constituents. The juice of the potato is acid, and contains vegetable acids combined with potash, soda and lime ; these give it its anti-scorbutic properties. The ash yields phosphoric and sulphuric acids, chlorine, silica, together with potash, soda, lime, magnesia, and oxide of iron.

It will thus be seen that the potato is chiefly remarkable for the large percentage of *starch* it contains, while it is poor in nitrogenous constituents, and contains scarcely any fat. Starch is largely extracted from potatoes for commercial purposes.

It has already been said that the potato is unfit to form an exclusive food, but it is a most valuable adjunct to other foods richer in nitrogenous substances, such as meat and fish.

The starch of the potato has the advantage of being very digestible; its granules are contained in the cells of the cellular tissue of the tuber, surrounded by the acid albuminous juices. In cooking, the albuminous juices are coagulated, the starch granules absorb the watery part of the juices, swell up, and break down the containing cells, so that the potato assumes a loose, "mealy" or "floury" appearance. If this change does not take place the potato is close, waxy, and watery.

To avoid the loss of salts, potatoes are best boiled in their skins, and steaming is the best method of cooking them, as they then lose none of their salts.

Although the potato is easily digested when "mealy" or "floury," it is not so when close and watery, and should not then be eaten by persons with feeble digestions. The value of the potato as a preventive of scurvy has been referred to; and it is therefore a useful vegetable to be taken on long sea voyages.

The quality and flavor of potatoes vary greatly with soil and season; those are best that are grown on sandy or readily permeable soils.

The Sweet Potato is rich in starch (sixteen per cent) and sugar (ten per cent). It becomes mealy when boiled, and is a wholesome and useful food, but too sweet to eat with meat as a vegetable.

The Yam is a good substitute for the potato, as it cooks "mealy," and forms a wholesome and agreeable food. It contains a large amount of starch, and has not the objection of being sweet like the sweet potato. It is grown in tropical climates.

The Jerusalem Artichoke is a well-known edible tuber. It has a sweet taste and remains watery after cooking, and does not become mealy like the potato; this is owing to its not containing starch. It is less digestible than the potato, and contains but very little nutritive substances, and is, therefore, practically of little importance as a food. It contains fourteen per cent of sugar, about three per cent of nitrogenous substances, and about two per cent of inulin, a principle isomeric with starch.

Arrowroot is a pure form of starch, highly valued as an easily-digested carbohydrate. It is cultivated in the West Indies and other tropical countries. That imported from Bermuda is considered the best. Arrowroot is simply a pure starchy food, and is valuable as a bland unirritating carbohydrate for invalids. It is usefully mixed with clear meat soups and extracts.

Tapioca, also a pure starch, is cultivated in Africa, India, and other hot countries. Its starch grains are small.

It is an agreeable and easily-digested carbohydrate, beneficial both for invalids and the healthy. It is usefully added to meat soups and broths, or made into puddings with milk.

Sago is another starch obtained from the pith of several species of palm. It is usually met with in the "granulated" form or "pearl sago," small spherical grains prepared by mixing sago-flour with water into a paste, and then granulating. It is used like tapioca for making light puddings and for adding to soups, and is a useful and easily-digested food for invalids and dyspeptics.

The following "roots" are of a more *succulent* nature, and are commonly used as *fresh* vegetables.

The Carrot is the root of the wild *Daucus carota* improved by cultivation. When young it forms a useful and wholesome food.

It contains a large proportion of water, eighty-five to eighty-eight per cent, and about eight per cent of carbohydrates, including a variable quantity of sugar; one per cent of salts, and rather more than one per cent of albuminates.

The Parsnip is much less frequently eaten than the carrot, which it closely resembles in food properties and composition, containing like it a considerable amount of sugar.

The Turnip is one of the cabbage tribe. It is a very popular vegetable, and the roots are largely cultivated as food for cattle. Its nutritive value is small, on account of the large proportion of water, ninety-one per cent, it contains. It contains six per cent of carbohydrates (starch, sugar, etc.), and about one per cent of nitrogenous substances. It would probably be more popular as a vegetable on account of its agreeable flavor were it not for its tendency to cause flatulence.

Beetroot is a most valuable vegetable. It is extensively cultivated as food, and for the extraction of sugar. It is not indigestible, except when tough and stringy. It contains about eighty-seven per cent of water, nine of carbohydrates, one and one-half of nitrogenous substances, and one of salts.

The Radish resembles the *turnip* somewhat in composition and flavor; it is however, more pungent, and is eaten rather for its agreeable flavor and its anti-scorbutic properties than as a food.

Green Vegetables. — The various, green, fresh, and succulent vegetables that are commonly regarded as suitable articles of food, such as the several members of the cabbage tribe, spinach, lettuce, asparagus, and others, are valuable not so much on account of the nutritious principles they contain, which are in small amount, as on account of the important inorganic salts they supply, especially the salts of

potash, and because of the agreeable flavor possessed by many, and the wholesome variety and relish they give to our food. Their anti-scorbutic properties are highly important. They contain a very large amount of water, often as much or more than ninety per cent. The amount of nitrogenous substances they contain is small, varying from about one and one-half to four per cent.

THE CABBAGE TRIBE is remarkable for the number of edible plants it contains. *Cabbages* (white and red), *greens*, *savoys*, *Brussels sprouts*, *cauliflower*, and *broccoli* are familiar examples. These contain a large proportion of sulphur, and therefore give rise during decomposition to a very disagreeable odor, and tend to occasion flatulence.. In the table published further on, the analysis of cabbage is given.

SAUER-KRAUT is a preparation of cabbage leaves, which are subject to a pressure between layers of salt and allowed to undergo acid fermentation.

CAULIFLOWER and BROCCOLI consist of the *inflorescence* of the plant altered by cultivation. It is one of the most delicate and most digestible of the cabbage tribe.

SEAKALE, which is grown excluded from light and thereby *blanched*, is also delicate, nutritious, and easy of digestion.

SPINACH is a wholesome and popular vegetable. It acts as a useful aperient, and is for that reason prescribed as a remedy for habitual constipation. Hence also its reputation for "clearing the complexion."

SORREL is used largely in France, as spinach is used in the United States. It is peculiar in having an acid taste, due to the presence of acid oxalates, and on that account it is considered as prejudicial to those who have any tendency to gout or gravel.

CELERY is esteemed for its agreeable aromatic flavor, and is eaten both raw and cooked; in the latter form it is specially wholesome and digestible.

It also has a popular reputation as being a cure for rheumatism if cooked and eaten freely.

ASPARAGUS. — This is a popular and delicate vegetable. It is remarkable as containing a crystalline alkaloid, *asparagine*, which is thought to possess diuretic properties.

LETTUCE AND WATERCRESS, are salad vegetables, and are generally eaten raw. They are cooling, anti-scorbutic, and wholesome, and easy of digestion when the digestive organs are sound.

THE ONION is valuable both as a condiment and a vegetable. It is wholesome and slightly laxative.

THE TOMATO, which is universally eaten, is refreshing and appetizing, and is valuable chiefly for its pleasant acid flavor. It is forbidden by many physicians to all those who have a tendency to gout or gravel, on account of its containing oxalic acid.

THE CUCUMBER is everywhere popular. It has an agreeable, refreshing flavor. It is 96·2 water.

The following gives the average composition of the chief succulent roots and green vegetables, excepting those already given :

	Carrots.	Turnips.	Celery.	Onions.	Cabbage.	Cauli-flower.	Brussels Sprouts.	Spinach.	Lettuce.	Asparagus.
Water	88·32	91·24	84 09	85·99	89.97	90·39	85·63	90·26	94·33	93·32
Nitrogenous Matters	1·04	0·96	1·48	1·68	1·89	2·53	4·83	3.15	1.41	1·98
Fat	0·21	0·16	0·39	0·10	0·20	0·38	0·46	0·54	0·31	0·28
Sugar	1·90	4·08	0·77	2·78	2·29	1·27	—	0·08	—	0·40
Other non-nitrogenous Extractives	7·17	1·90	11·03	8·04	2·58	3·74	6·22	3·26	2.19	2·34
Cellulose	0·95	0·91	1·40	0·71	1·84	0·87	1·57	0·77	0·73	1·14
Ash	0·71	0·75	0·84	0·70	1·23	0.82	1·29	1.94	1·03	0·54

EDIBLE FUNGI. — Many species of fungi are suitable for food, but we will mention but one, namely the mushroom.

MUSHROOMS are largely consumed, but chiefly on account of their agreeable flavor. In the analysis of mushrooms, water is ninety parts and albuminoids three parts.

FRUITS.

A great variety of fruits, both in the fresh and dried state, are consumed as articles of food or as flavoring agents and luxuries.

The following are the principal varieties made use of, some being of native growth and others imported:

1. The apple, pear and quince.
2. The orange, lemon, lime and shaddock.
3. The plum, peach, apricot, cherry, olive, date (stone fruits).
4. The grape, gooseberry, currant, cranberry, barberry.
5. The strawberry, raspberry, blackberry, mulberry.
6. Melon, pine-apple, fig, banana.

The following table gives the average composition of some of the most important of these:

	Apple.	Pear.	Peach.	Grape.	Straw-berry.	Cur-rants.	Orange (pulp only).
Water	83·58	83·03	80·03	78·18	87·66	84·77	89·01
Nitrogenous Matters	0·39	0·36	0·65	0·59	1·07	0·51	0·73
Free Acids	0·84	0·20	0·92	0·79	0·93	2·15	2·44
Sugar	7·73	8·26	4·48	14·36	6·28	6·38	4·59
Other non-Nitrogenous Matters	5·17	3·54	7·17	1·96	0·48	0·90	0·95
Cellulose and Kernel	1·98	4·30	6·06	3·60	2·32	4·57	1·79
Ash	0·31	0·31	0·69	0·53	0·81	0·72	0·49

The following gives the composition of certain dried fruits:

	Apple.	Cherry.	Raisin.	Fig.
Water	27·95	49·88	32·02	31·20
Nitrogenous Matters	1·28	2·07	2·42	4·01
Fat	0·82	0·30	0·49	1·44
Free Acid	3·60	——	——	1·21
Sugar	42·83	31·22	54·26	49·79
Other non-Nitrogenous Matters	17·0	14·29	7·48	4·51
Cellulose and Seeds	4·95	0·61	1·72	4·98
Ash	1·57	1·63	1·21	2·86

The analysis of the ash shows these fruits generally to be particularly rich in potash salts. The apple and the strawberry are rich also in soda salts, especially the strawberry. They also contain salts of lime, magnesia, and iron.

It will be seen from the above tables that these fruits possess but a low nutritive value, as they contain a very large proportion of water, and of their solids only a very small proportion consists of nitrogenous matters. Their chief food value is in the sugar which they contain. This, in some, is considerable. They also contain important salts of vegetable acids (malates, citrates, tartrates) as well as some free acid.

They therefore possess valuable *anti-scorbutic* properties. As their salts are chiefly combinations of vegetable acids with alkalies, and as these become converted into carbonates in the system, they impart alkalinity to the urine, and they are, on that account, valuable in gouty states with a tendency to the deposition of acid urates.

Many contain small quantities of fat, and waxy and coloring matters. Their agreeable aroma is due to the presence of essential oils and compound ethers. They all contain

varying amounts of indigestible cellulose and *pectin* or vegetable jelly. Malic acid is found in apples, pears, peaches, apricots, gooseberries, and currants; tartaric acid in grapes; and citric acid in lemons, oranges, etc.

When taken in moderate quantity these fruits are useful additions to the dietary: they are cooling and refreshing, of agreeable flavor, and tend to promote intestinal action and to correct tendencies to constipation. Taken in excess, or when immature, or over-ripe, they are apt to set up gastro-intestinal irritation, often of a severe form.

Most of these fruits are so well known that any detailed description of them would be superfluous.

The Apple when cooked, and of good quality, is easy of digestion, cooling, and slightly laxative.

Pears of the best quality, when ripe, are better suited for being eaten *raw* than apples, as their flesh is soft and "melts in the mouth."

Oranges are especially valuable for invalids; when ripe and well selected they are pleasant and refreshing, and very grateful for allaying thirst in feverish conditions.

The Lemon and its congeners, the lime and shaddock, are important as yielding a useful anti-scorbutic juice, and for giving an agreeable pungency and flavor to insipid and tasteless foods.

Plums should be avoided in the unripe and over-ripe states, and they are more apt than other fruits to prove indigestible and irritating, and to cause diarrhœa. Dried plums (prunes) are often judiciously added to the daily dietary to remedy habitual constipation.

Peaches and Nectarines are particularly delicate-flavored and refreshing. Owing to the small quantity of sugar they contain, and their soft and delicate flesh (when ripe) they are well suited to the gouty and diabetic.

Currants, Gooseberries, Bilberries, and Raspberries

are remarkable for the amount of *free* acid they contain, which makes them very refreshing and their juices form an agreeable addition to effervescing water.

The Mulberry is also very refreshing, and has slightly laxative properties.

The Strawberry is one of the most popular of fruits, and is very wholesome when taken in moderation. It is considered to be a useful food for the gouty on account of its richness in alkaline salts (potash, soda and lime) and its cooling, diuretic, and laxative qualities. There are some physicians who forbid this fruit to the gouty, but it is only in a few rare cases that it is found to disagree. French authors maintain that its flavor is enhanced by the addition of some acid juice, such as orange or lemon juice, or a few drops of good vinegar.

The Grape is a very important fruit, on account of its richness in sugar, both in the fresh and dried (raisins) forms. It is very digestible when fully ripe and most acceptable to invalids.

The Melon is perhaps the most watery of all the fruits, containing, as it does, more than ninety-five per cent of water; notwithstanding this it is apt to prove very indigestible, and to give rise to gastric disturbance.

Figs both in the green and dry state contain much sugar, and also a rather large proportion of nitrogenous matters, so that they are more nutritious than most fruits; in large quantities they are apt to prove aperient.

The Date is also a highly nutritious fruit, and forms an important food for the Arabs.

The Banana and Plantain are also nutritious fruits, as they contain much sugar and certain proportion of nitrogenous matters.

OILS, FATS, STARCH AND SUGAR.

The oils or fats, hydro-carbons, form a very distinct and important section of the group of heat-givers. Like starch and sugar, they can form no muscular tissue, but their power of maintaining the heat and activity of the body is nearly two and one-third times that of the starchy nutrients. So far as their feeding properties are concerned, oils are identical with fats, the distinction between the substances thus named referring chiefly to their condition of liquidity or solidity.

The quantities of oil or fat contained in some important vegetable and animal products are quoted in the following table:

OILS OR FAT IN 100 POUNDS OF

	lb.		lb.
Palm-nuts	72	Hemp seed	32
Brazil-nuts	67	Walnuts	32
Almonds	54	Cotton seeds	24
Ground-nuts	52	Sunflower seeds	22
Poppy	45	Oatmeal	10
Olives	44	Corn	5
Cacao	44	Millet	3
Linseed	38	Peas	2½
Coco-nut	36	Rice	0½

FAT IN ANIMAL PRODUCTS.

	lb.		lb.
Butter	87	Eggs (yolk and white)	11
Bacon	65	Cows' milk	4
Cheese	30	Flesh of poultry	1
Mackerel	13		

Oils are most abundant in the fruits and seeds of plants, and are present in insignificant quantities in their roots,

stems and leaves. Of the vegetable oils extracted and used as oil in preparing and cooking food, olive oil, expressed from olive pulp, is the most important.

Many kinds of fruits, nuts, or seeds are eaten mainly on account of the oil they contain. Amongst these may be named: almonds, chestnuts, walnuts, hazel-nuts, Brazil-nuts, pecan-nuts, hickory-nuts, pistachio-nuts, etc.

Oils and fats are but little changed during digestion. They are divided into minute particles or globules, and then form what is called an *emulsion*. This emulsification is mainly caused by the pancreatic juice; the finely divided globules of oil and fat are then absorbed by the *villi* of the small intestine.[1]

Besides its great use as a giver of heat, and therefore of mechanical force or energy, fat performs an important function in the body as the chief material of the adipose tissue. This fatty layer, where it exists beneath the skin, keeps in the warmth of the body; while such stores of fat as exist in this form throughout the organism may be re-absorbed into the blood, and keep up the animal heat and activity during abstinence from food.

STARCH AND SUGAR.

Starch and sugar are rich in carbohydrates. Starch is, perhaps, the most important.

The following table gives the quantities of starch in 100 pounds of several kinds of vegetable products and preparations:

	lb.		lb.
Sago, tapioca, arrowroot, cornflour, maizena	83	Millet	64
Pearl barley	76	Oatmeal	63
Rice	76	Beans	52
Rye	71	Peas	51
Wheat	69	Potatoes	18
Corn	66	Parsnips	3
Buckwheat	64	Vegetable marrow	0½

[1]See chapter on "Digestion."

Some of these numbers include with the starch small quantities of dextrin, sugar, and gum—substances which subserve the same purposes in the animal system.

No starch can furnish the materials for the building up and repair of flesh or muscle; it is, however, next to oil and fat, the most concentrated, heat-giving, and force-producing of all the nutrients. To be digested, starch must be dissolved, or at least softened. These changes are effected by boiling in water, or baking in the presence of moisture, for starch is insoluble in cold water. Thus the digestion of starch may be said to commence in its preparation by cooking. It proceeds further through the action of the saliva[1] during mastication. Starch, during digestion, is partly and temporarily changed into dextrin.

Sugar is distinguished from starch by its solubility in cold water and its sweet taste. Its composition is slightly different also. But there are several kinds of sugar, which must be considered separately.

Grape-Sugar. — When the ripe grape is dried in the air, it forms the well-known raisin of commerce. When this raisin is opened, numerous whitish crystalline brittle granules are seen within it, which are sweet to the taste. These consist of what is called grape-sugar, and they are the main source of the sweetness both of the grape, and the raisin, and the currant.

Though grape-sugar or glucose comes only second in importance to cane sugar, in this article it is treated first. As the latter sugar is found in many plants besides the sugar-cane, so grape sugar is abundantly distributed through the vegetable kingdom. More than this, it may be readily made from starch, as will be noted further on. But, perhaps, a still more remarkable fact is, that paper, raw cotton and flax,

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[1]See chapter on "Digestion."

cotton and linen rags, and even sawdust, are now used for the manufacture of grape sugar, or glucose.

Fruit Sugars. — Many of our fruits pass, in the course of ripening, from a sour to a sweet taste. The apple, the pear, the plum, the peach, the gooseberry, the currant, the cherry, etc., are of this kind. Most of them, even when fully ripe, are still a little acid; the mixture of sweet and sour in their juices adding to their agreeable and refreshing qualities. All such fruits, as a general rule, contain, and owe their sweetness to grape-sugar. From many of them this sugar can be readily extracted for use; but, in general, it is more economical and agreeable to employ it in the form of dried and preserved fruits.

Starch-Sugars. — It is a property of starch of all kinds to be insoluble in cold water, but to dissolve readily in boiling water, and to thicken into a jelly or paste as it cools. Even a lengthened boiling in water, however, produces little further change upon it. But if a small quantity of sulphuric acid (oil of vitriol) be added to the water in which it is boiled, the solution gradually acquires a sweet taste, and ultimately the whole of the starch is converted into grape or honey sugar.

Cane-Sugar.—The plants or fruits which possess distinctly acid or sour juices, yield grape-sugar, though often accompanied by cane-sugar. Those which have little acid in their saps, contain for the most part cane-sugar. The principal varieties of cane-sugar known in commerce are, cane-sugar properly so called, beet-sugar, palm or date sugar, maple-sugar, and maize-sugar. We will discuss only the former.

Sugar-Cane.—The sugar-cane is still the chief source of the sugar of commerce, although an increasing quantity is obtained from beet. The sugar-cane was almost unknown to the Greeks and Romans. Now cultivated most extensively

in America, it is a native of the Old World. It was familiar in the East in most remote times, and appears to have been cultivated in China and the South Sea Islands long before the period of authentic history. Through Sicily and Spain it reached the Canary Islands, thence was transplanted to St. Domingo by the Spaniards in 1520, and from this island it has gradually spread over the West Indies and the tropical regions of the American continent. It flourishes best where the mean temperature is from 75° to 77° Fahr., but it thrives and can be economically cultivated, where the mean temperature does not exceed 66° to 68° Fahr. It rarely ripens its seed, however, even in the most propitious localities. Young plants are raised, therefore, from portions of the stem planted for the purpose; and when cultivated for sugar, they are rarely allowed to come to flower.

There are many varieties of the sugar-cane, as there are of nearly all long-cultivated plants. In general, the varieties most common in each country and district are best adapted to the local climate and to the soils in which they grow. Those which yield the sweetest juice, and in the greatest abundance, if otherwise suited to the climate, are the most esteemed. In Louisiana, five different varieties are cultivated. In many tropical regions, however, the sugar-cane forms a staple part of the ordinary food. The ripe stalk of the plant is chewed and sucked, and almost incredible quantities are consumed in this way.

It is plentiful in the markets of Barbadoes and New Orleans. In the Sandwich and many other islands of the Pacific, every child has a piece of sugar-cane in its hand; while in Cuba, a great field of supply for the United States, the negroes become fat in crop time on the abundant juice of the ripening cane.

This nutritive property of the raw juice of the sugar-cane arises from the circumstance, that it contains, besides the sugar to which its sweetness is owing, a small but distinct

proportion of gluten, as well as of those necessary mineral substances which are present in all our staple forms of vegetable food. It is thus itself a true food, capable of sustaining animal life and strength without the addition of other forms of nourishment. This is not the case with the sugar of commerce, which, though it in a certain sense helps to nourish us, is unable of itself to sustain animal life.

The sugar-cane varies in composition and richness with the variety of cane, the nature of the soil, the mode of cultivation, the character of the climate, and the dryness of the season. Its average composition in sugar plantations, when the canes are fully ripe, is about —

Sugar	18
Water	71
Woody fibre and carbohydrates	9½
Saline matter	½
Gluten and nitrogenous matter	½
Coloring matters	½
	100

For the extraction of the sugar, the canes are cut with a large knife, the laborer proceeding between the rows. The leaves and tops are then chopped off and left in the field, or used for fodder, while the under ripe part is carried to the mill. The yield of trimmed canes from an acre varies from one to three tons in fifteen months. These ripe canes are passed between heavy iron crushing-rollers, which squeeze out the juice. This juice is run into large vessels, where it is clarified by the addition of lime and other applications. The action of this lime is twofold. It removes or neutralizes the acid which rapidly forms in the fresh juice, and at the same time combines with the gluten of the juice, and carries it to the bottom. This gluten would act as a natural ferment, causing the sugar to run to acid. Its speedy removal, there-

fore, is essential to the extraction of the sugar. After being clarified in this way, and sometimes filtered, the juice is boiled rapidly down, is then run into wooden vessels to cool and crystallize, and finally, when crystallized, is put into perforated casks to drain. What remains in these casks is raw sugar; the drainings are well known by the name of molasses.

From this raw sugar, all the varieties of refined sugar are made.

WATER AND MINERAL MATTER.

WATER.

This important constituent of food is the carrier of food into and through the system, and forms more than two-thirds of the whole body. Water is contained not only in the liquids drank as beverages, but in all kinds of solid foods.

QUANTITIES OF WATER IN 100 LB. OF DIFFERENT KINDS OF FOOD.

Vegetable Food.

	lb.		lb.
Oatmeal	5	Grapes	80
Wheat flour	13	Parsnips	81
Corn meal	14	Beetroot	82
Barley meal	14	Apples	83
Peas	14	Carrots	89
Beans	14	Cabbages	89
Rice	15	Onions	91
Bread	40	Turnips	93
Potatoes	75	Lettuce	96

Animal Food.

	lb.		lb.
Butter	10	Mutton	71
Bacon	22	Eggs	72
Cheese	34	Lean of meat	73
Fat Pork	45	Fowl	78
Fat Beef	55	Herring	80
Salmon	64	Milk	87

Although the above proportions of water seem generally large, these foods do not suffice alone to supply all the water required by man. As every pound of perfectly dry food should be accompanied by about four pounds of water, it is found necessary to consume water itself, or some beverage containing little else but water.

DRINKING WATER.

Water is an indispensable beverage; as a solvent agent it is needed in all the important chemical changes connected with nutrition; it is a valuable diuretic; it is absorbed rapidly and eliminated rapidly. It has been justly said that the use of an abundance of water as a beverage promotes a sort of "washing" of the various tissues of the body; that when taken at the end of stomach digestion it carries undigested substances out of the stomach into the small intestine. Hence the necessity of having pure water for drinking purposes, cannot be too strongly urged.

SALTS OR MINERAL MATTER IN FOOD.

These occur in most drinking waters, and are found also in all parts of plants and animals used as food; while one of them, common salt, the chloride of sodium, is added purposely to food — indeed is the only solid mineral substance so added and consumed.

The quantity of mineral matter contained in some important articles of vegetable and animal food is shown in this table:

MINERAL MATTER IN 1,000 LB. OF FOURTEEN VEGETABLE PRODUCTS.

	lb.		lb.
Apples	4	Bread	12
Rice	5	Watercress	13
Wheat flour	7	Corn	20
Turnips	8	Oatmeal	21
Potatoes	10	Peas	30
Barley	11	Cocoa nibs	36
Cabbage	12	Wheat bran	60

MINERAL MATTER IN 1,000 LB. OF EIGHT ANIMAL PRODUCTS.

	lb.		lb.
Fat pork	5	Flesh of common fowl	16
Cow's milk	7	Bacon	44
Eggs (without shells)	13	Cheese	49
Lean of mutton	17	Herrings	29

It is not to be supposed that the mineral matter entered in these tables is in all cases of the same composition. It varies greatly in the different products named. In most seeds and fruits there is much phosphate in the mineral matter, and in most green vegetables much potash. One important kind of mineral matter alone is deficient in vegetable food, and that is common salt. This compound must be added in large quantity to the food of persons living exclusively on vegetables; while, on the other hand, there is no better way of counteracting the bad effects on the human body of a salt-meat diet than the use of lemon-juice and fresh green vegetables, which are rich in potash salts.

TEA, COFFEE, CACAO.

TEA.

The plant which yields the tea of commerce is a native of Bengal. Our supplies come mainly from China, India, Ceylon and Japan. In the last-named country the tea-plant occupies about two and one-half per cent of the cultivated land; much of the produce is retained for home consumption, but a good deal is exported to the United States.

The tea-plants are raised from seed which, to secure germination, is kept over winter in moist earth, and sown in March. When a year old, the young bushes are planted, and then by cropping the main shoot for the first year they are kept down to a height of about three feet, and made to grow bushy. Being placed in rows three or four feet apart, they have some resemblance to a garden of gooseberry-bushes. The cropping of the leaves begins in the fourth and fifth years. and is seldom continued beyond the tenth or twelfth, when the bushes are dug up and renewed. The plant thrives best on dry sunny slopes, where occasional showers fall and springs appear, and where an open, somewhat stony but rich soil, prevents the water from lingering about its roots. The season for gathering varies in different districts, but the principal leaf-harvest ends in May or June. The leaves are plucked by hand, and chiefly by women. They are generally gathered at three successive seasons. The youngest and earliest leaves are the most tender and delicate, and give the best-flavored tea. The second and third gatherings are more

bitter and woody, and yield less soluble matter to water. The leaves when freshly plucked have neither a decidedly astringent, an aromatic, nor a bitter taste. They possess nothing, in fact, either of the odor or flavor of the dried leaves. The pleasant taste and delightful natural scent for which they are afterwards so highly prized, are all developed by the roasting which they undergo in the process of drying.

GREEN TEA is prepared from the *young* leaves, which within an hour or two after being gathered are roasted in pans over a brisk wood fire. After four or five minutes' roasting they are rolled by hand, and again thrown into the drying pans, where they are kept in rapid motion for about an hour and a half. The process is simple, and speedily accomplished.

For BLACK TEA, the leaves are allowed to lie in heaps for ten or twelve hours after they have been gathered, during which time they undergo a sort of fermentation. They are then tossed about till they become soft and flaccid, and after being rolled are alternately heated and rolled three or four times. The leaves are afterwards dried slowly over charcoal fires.

Good average black tea, as imported, may be fairly represented by the following figures :

	In 100 parts.
Water	8·0
Albuminoids	17·5
Theine	3·2
Tannin	17·5
Chlorophyll and resin	4·5
Essential oil	0·4
Minor extractives	8·6
Cellulose, etc.	34·0
Mineral matter	6·3

As to the effects of tea as an article of diet much difference of opinion exists, and especially as to the relative value of

tea and coffee. It should be recognized that there often exist great individual peculiarities with regard to the effects of these beverages, and hence the conflict of opinion on this point.

We do not believe tea to contain a great amount of actual nutritive value, but it does act as a stimulant and restorative to the nervous system. It removes fatigue, rouses and clears the mind, and promotes intellectual energy. The stimulating effects of tea upon the nervous system are due to the essential oil and the theine: the tannin is an astringent. It has been estimated that half the human race now use tea either habitually or occasionally.

COFFEE.

The shrub or small tree which yields the seed coffee is a native of Abyssinia. The tree is said to have been transplanted into Arabia at the beginning of the fifteenth century, and the cultivation has since been so extended that coffee is now grown throughout the tropics. Large supplies come from Ceylon, Java, the West Indies, South and Central America.

The coffee-tree when in good health and full grown, attains a height in some countries not exceeding eight or ten, but in others averaging from fifteen to twenty feet. It is covered with a dark, smooth, shining, and evergreen foliage. It is sown in nurseries — transplanted when about six months old — begins to flower at two years, and in three years comes into full bearing, and in favorable circumstances will continue to bear for twenty years. And it does this in all seasons, so that throughout the year its white blossoms delight the eye, and its red fruit enriches the owner. It flourishes in a dry soil and a warm situation, but not too warm: and hence in hot climates it grows best at an elevation of one thousand or one thousand five hundred feet above the level of the sea. Coffee grows from the equator to thirty-six degrees north lati-

tude, in damp and shady situations. It gives three crops a year. Its flowers are pale white, fragrant, and rapidly fading; its fruit is like that of the cherry-tree, but it grows in clusters. Within the fruit are the seeds or "berries." On dry and elevated spots the berries are smaller, and have a better flavor; but berries of all sizes improve in flavor or *ripen* by keeping.

The coffee produced by different countries presents variations in quality and the physical characters of the bean. The smallest bean, as just stated, is considered the best. *Mocha* or *Arabian* coffee is the most highly esteemed. The bean is small and round, and of a dark yellow color, with a tinge of green. This variety develops a more agreeable aroma than the others. *West Indian* coffee is usually of a greenish-grey tint, with the ends of the beans rounded. A slight difference exists in the production of the various islands. *Jamaica* coffee, for instance, does not exactly resemble that from *Martinique*, and the coffee from *St. Domingo* is less esteemed than either, and is pointed at the two extremities. *Java* and *East Indian* coffee is large, and of a pale yellow color. *Ceylon* coffee is the least prized of all.

Roasted Coffee generally contains—

	In 100 parts.
Water	2·0
Albuminoids	12·5
Theine (Caffeine)	1·0
Fat or oil	12·5
Tannin	5·0
Minor extractives	14·4
Cellulose, etc.	48·0
Mineral matter	4·6

The sensible properties and effects of coffee, like those of tea, are too well known to require to be stated in detail. It exhilarates, arouses and counteracts the stupor occasioned by fatigue. It has little direct nutritive value except when taken, as it usually is, with milk and sugar. Yet it allays hunger to a certain extent and gives to the weary increased strength and vigor. Its physiological effects upon the sys-

tem, so far as they have been investigated, appear to be that, while it makes the brain more active, it soothes the body generally, makes the change and waste of matter slower, and the demand for food in consequence less. All these effects it owes to the conjoined action of three ingredients, very similar to those contained in tea. These are, a volatile oil produced during the roasting — a variety of tannic acid, which is altered during the roasting — and the substance called theine or caffeine, which is common to both tea and coffee. It increases the secretion of the kidneys and of the skin, and in some persons it will stimulate the peristaltic movement of the intestine, and so act as an aperient.

CACAO.

Cocoa and chocolate, both used in cooking and in making beverages bearing their respective names, are the product of the cacao bean.

Cacao beans grow in cacao pods, and cacao pods grow on and are the fruit of the cacao tree. *Theobroma cacao* is indigenous in South America, Mexico, and the West Indies, and is cultivated in the island of Ceylon, and other parts of the world. The largest harvest of cacao is gathered in South and Central America, and the West Indies.

The cacao tree grows quite similar to an apple tree, having wide spreading branches, and a trunk averaging seven inches in diameter. It takes about five years for this tree to mature, after which, it continues to bear fruit for forty years, yielding two crops per year, one each six months.

A singular fact is, that the pods do not grow from the twigs and small branches, but directly from the trunk and from the big limbs.

When the pods have become ripe, they are cut from the tree, opened, the beans removed and cured. They are then packed in bags, holding from two hundred to two hundred and fifty pounds, and sent out to the markets of the world.

Roasting the bean develops the aroma and removes the brittle, outside husk. The beans then easily break into small fragments, called "nibs." These nibs are one-half cacao butter. Grinding the nibs, produces, because of the butter, a liquid paste. This, run into molds, becomes, on cooling, hard and solid, and is known as chocolate. If sugar, or sugar and vanilla, are added, it is known as "sweet" or "vanilla" chocolate.

In making the product known as cocoa, a part of the rich butter is removed from the liquid paste. Then the latter is dried and finely pulverized. The difference between chocolate and cocoa, is this: the latter contains less fat than the former.

COMPOSITION OF CACAO.

Cacao butter	48	to	50
Albumen, fibrine, and other nitrogenous matter	21	"	20
Theobromine	4	"	2
Starch with traces of sugar	11	"	10
Cellulose	3	"	2
Mineral matter	3	"	4
Water	10	"	12
	100		100

The predominating ingredient in cacao, as seen above, is the large proportion of fatty matter, known as cacao butter, which it contains. This amounts to one-half the weight of the bean. Consumed in either of its more usual forms, therefore, cacao is a very rich article of food.

Containing, as pure cacao does, twice as much nitrogenous matter, and twenty-five times as much fatty matter as wheat flour, with a notable quantity of starch and an agreeable aroma to tempt the palate, it is rich in all the important nutritious principles which are found to co-exist in our most valued forms of ordinary food. It cannot be otherwise than a valuable alimentary material. It has been compared in this respect to milk. It conveniently furnishes a large amount of agreeable nourishment in small bulk.

DIGESTION.

I. What we Digest.—Whether we sustain ourselves by means of vegetable or of animal food, we introduce nearly the same substances into the stomach. These different forms of food consist in the main, respectively—

The *bread*—of gluten, starch or fat, and saline matter.
The *beef*—of fibrin, fat, and saline matter.

Gluten and fibrin on the one hand, and starch and fat on the other, serve similar purposes, and may take the place of each other almost indifferently in a nutritious food. These, therefore, along with the saline matters contained in both animal and vegetable food, are the main substances we digest. It is true that vegetable food contains also insoluble substances called cellulose or lignose—the materials of the cell-walls and vessels of plants. The digestive organs extract, from among the useless materials which the food may contain, the three staple forms of matter above described. We have only to follow these substances into the body, therefore, and see what becomes of them.

II. How we Digest.—The process of disgestion involves three successive series of operations, mechanical and chemical. The first of these takes place in the mouth, the second in the stomach, and the third in the intestines.

1°. *What takes place in the mouth.*— In ripe fruits and other kinds of vegetable food prepared by nature for immediate eating, the solid nutritious matter they contain is very minutely divided, and is intermixed with a large proportion of water. The first object of the cook, in many cases, is to bring the raw food into the same minutely divided and highly diluted

condition. But all the food we eat is not so prepared, either by nature or by art. The first operation we perform upon it, is to grind it, if necessary, by means of the teeth, and to dilute and season it by means of the warm, fluid, salt-containing saliva. It is then swallowed, and allowed to descend to the stomach.

This operation appears to be altogether mechanical; and yet the chemical history of the saliva, which takes so great a part in the operation, and the relations of this saliva to the food, are both interesting and important. The saliva is secreted in glands which open into the interior of the mouth, and which, in some animals, are of large size. The quantity of liquid which these glands discharge into the mouth, and thence into the stomach, is very variable. In the case of the full-grown man it is sometimes as low as eight and sometimes as high as 21 ounces in the twenty-four hours. According to some authorities as much as 70 ounces may be formed.

The saliva consists for the most part of water, and therefore, as I have said, its first function is to dilute the solid food. But this water holds in solution about half a per cent of organic and saline matter. In the 21 ounces sometimes swallowed in a day, there are about 20 grains of this saline matter. But this saline matter, half of which is chlorides, is accompanied by a peculiar organic matter, an unorganized ferment, to which, from its occurring only in the saliva, the name of *ptyalin* is given. Like the diastase[1], ptyalin possesses the property of changing the starch of the food into sugar. This property it exhibits in perfection, when the starch is dissolved or cooked, and when the temperature of the liquid approaches 98° F., when used alone—according to others, only when mixed with the saline constituents of the saliva. It forms less than one five-hundredth part of the whole

[1] *Diastase.*—A substance containing nitrogen, generated during the germination of grain for the brewery, and tending to accelerate the formation of sugar during fermentation.

weight of the saliva. Not more, therefore, than a few grains of it are swallowed by a healthy man in the twenty-four hours; yet this small quantity is really of much consequence to the easy and comfortable digestion of the food. Hence it is that experience has recommended to all good livers a careful mastication of their food, that all parts of it may be thoroughly mixed with the saliva, and thus subjected to its chemical action.

Two other facts regarding the saliva are of much interest as wonders of the human frame, independent altogether of their intimate relation to the process of digestion. One of these is, that the saliva has generally an alkaline[1] character—that this *alkalinity* is greater during and immediately after eating, and gradually lessens, till after long fasting the saliva becomes acid—that it is greater, also, after substances have been eaten which are difficult of digestion—and that, when the saliva discharged into the mouth is spat out instead of being swallowed, acidity and heartburn often ensue—(WRIGHT). These circumstances argue not only a close connection between the process of digestion and the alkaline character of the saliva, but an immediate watchfulness, as it were, over the immediate wants of a particular bodily organ.

The other fact is, that as soon as food is swallowed, the saliva begins to flow more copiously than before. This is the case even if the food be swallowed without chewing. Or if food be introduced by an artificial opening into the stomach, without passing through the mouth at all, the saliva will forthwith begin to discharge itself into the mouth, with its alkaline character, and hasten down the throat to assist in the digestion. It appears strictly correct to say that the saliva is constantly on the watch to be useful, when we recollect how the mouth will often "water" at the mere mention of savory articles of diet.

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[1] Substances are *alkaline* which have the taste of pearl-ash or common soda, or which restore the color of vegetable blues that have been reddened by an acid.

When chewed and duly thinned with saliva, and, from the ropy character of the latter, mingled with a certain quantity of air, and therefore of oxygen, the food is rolled by the tongue, and is swallowed or forced down the gullet or œsophagus on its way to the stomach.

2°. *What takes place in the stomach.*[1] — The stomach, into which the food descends through the gullet, is an oblong rounded bag, capable, when moderately distended, of containing two or three pints.

The food after it reaches the stomach is mixed up with more water if it has not been already sufficiently diluted. It is intermingled, at the same time, with certain liquids which flow out of minute openings on the inner surface — the mucous membrane, as it is called — of the stomach. And after these admixtures, it is digested for an indefinite period, at a constant temperature of about 98½° F.

But during this digestion it undergoes certain chemical and mechanical changes. Thus —

First, The *starch*, through the continued agency of the saliva, and especially of the ptyalin it contains, is gradually converted for the most part into the variety of sugar called *glucose* or grape-sugar. It then dissolves, and is ready to be conveyed towards its further destination.

Secondly, The *fat*, without undergoing any known chemical change, is subdivided into exceedingly minute globules, and is intermingled intimately with the other half-fluid portions of the food. With these it forms in this way a kind of emulsion, and is then also ready to pass on.

Thirdly, The *gluten and fibrin*, and similar nitrogenous nutrients, which are solid when swallowed, are also reduced in the stomach to the fluid form. But this is effected by means of a new agency.

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[1]For picture of stomach and the neighboring organs which are concerned in the process of digestion, consult some good medical work.

Within the mucous membrane which lines the interior of the stomach, many little cavities or hollows are situated. From the surfaces of some of these, a liquid, which is known by the name of the gastric juice, flows into the stomach. This liquid contains saline matter, a quantity of free acid which renders it slightly sour, and a peculiar organic substance to which the name of *pepsin* has been given. This last substance is present in the gastric juice only in minute proportions. Like the ptyalin of the saliva, however, it exercises a powerful and important action upon the food. While the ptyalin changes the starch, first into sugar, and afterwards partially into lactic acid, the pepsin, with the aid of the free acid, reduces the fibrin of flesh to the liquid state. The curd of milk and the white of egg are also readily changed by the gastric juice into soluble forms. Upon gelatinous substances it exercises a speedily dissolving action; and upon the gluten of wheat, though a little more slow, its final effect is the same. These dissolved albumens, fibrins, and caseins are, however, not merely dissolved; they are so altered by the pepsin ferment and the acid that they can pass through membranes and cell-walls which before they could not do. They are now called *peptones*. Of the gastric juice as much as 60 to 80 ounces are supposed to be poured into the stomach of a well-fed grown man every twenty-four hours.

Thus, by the conjoined chemical agency of the saliva and the gastric juice — aided by the uniform warmth of the stomach — the fat, the starch, and the gluten of the food are all brought into a half-fluid state. The saline matter of the food is in part changed and dissolved by the same agencies. The whole forms a greyish, gruel-like, slightly acid food-pulp, which has been called chyme.

This chyme now flows through the narrow outlet from the stomach — the pylorus — into the upper part of the small intestines, which, from its length of twelve inches, has been called the duodenum.

All the food, however, which enters the stomach does not thus linger in the stomach itself, or thus pass downwards through the pylorus.

What we swallow in the liquid state — our gruels and gravy-soups, for example — requires no dissolution or breaking down in the stomach, though they experience the other changes named — starch being in part turned into sugar, and albumen, etc., into peptones. They pass on, therefore, with little delay, and for the most part descend through the pylorus into the duodenum in a comparatively short period of time.

And again, from the moment that our solid food begins to dissolve in the stomach, it begins also to be absorbed through the sides of the stomach itself. Minute blood-vessels spread over the whole internal surface of the stomach, drink in liquid parts of the food through their thin walls, and carry them away to be mingled with the general blood. Thus, a variable proportion of the food never reaches the pylorus, or descends into the duodenum. Thus, also, the process of nourishment begins almost as soon as the food is introduced into the stomach. The strength is kept up by one part of it, while the rest is undergoing the necessary process of chemical preparation.

3°. *What takes place after it leaves the stomach.*— A small vessel or tube proceeds from the gall-bladder, and enters the duodenum a little below the pylorus, or outlet of the stomach. Another vessel comes in from the pancreas[1] or sweetbread. The former pours bile into the intestine; the latter, a thin saliva-like liquid, called the pancreatic juice. At the same time, from the surface of the intestine itself, a peculiar half-liquid slimy mucus exudes, which is called the intestinal juice (*succus entericus*). With these three liquids the food-pulp or

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[1] *Pancreas.*—A whitish conglomerate gland, of irregular shape, situated deep in the abdomen, beneath the stomach, and pouring its secretion into the ailmentary canal during digestion. It is one of the most important of the digestive organs.

chyme almost immediately mixes as it passes onward from the stomach. When so mixed it loses its acid character, some (often all) of the starch still unchanged is here converted into sugar, and the albumens into peptones, and it becomes milky in appearance. It is now changed into chyle.[1]

The first chemical effect of the bile is to remove the acidity of the food-pulp. Its subsequent action is not well understood, but its presence is known to be necessary to healthy and nutritious digestion. It restrains the tendency of the food to fermentation, and to that form of decay, or decomposition, which is indicated by flatulence and the occurrence of diarrhœa. It also provokes the surface of the intestines to discharge more copiously the intestinal juice, and it tends to keep the bowels in movement.

The pancreatic juice resembles the saliva very much in appearance. Like the saliva, also, it contains saline matter, and a peculiar organic compound, which, however, is different from the ptyalin of saliva. In common with ptyalin, this compound body possesses the property of converting starch into sugar, and thus continues in the bowels the transformation of the starch which the ptyalin had begun in the stomach. It exercises a peculiar action, however, upon the fat of the food, reducing it to a more minute state of division than before, converting it into a more perfect emulsion (a property it shares with the bile), and giving to the chyle its characteristic milky appearance. Its special duty is believed to be to promote the digestion of oily and fatty food.

The intestinal juice aids the action of the fluid of the pancreas. It has the property of changing starch into sugar, and at least assists in emulsifying the fat.

This latter action is inferred from the fact, that the solution of the whole food is much more complete and rapid when it

[1]*Chyle.*—A milky fluid, consisting of the fatty matter of food in a state of emulsion, or fine mechanical division, with the intestinal juices.

is mixed with all these fluids in succession, or to some extent together, than when treated with one of them only. They complete the chemical action of each other, so that the resultant action of the saliva, the gastric juice, the intestinal juice, the bile, and the pancreatic fluid, is that of a kind of "universal solvent," by which all that the food contains of a nutritious quality is melted together, as it were, and fitted to enter the absorbent vessels.

And now the chyle being formed, a new variety of absorption begins. While within the stomach, the fatty portions of the food were still too little reduced to admit of their being taken up in suitable quantity by the absorbent vessels. The liquid which these took up was the watery lymph. But the fats broken up by the bile and the pancreatic juice are absorbed by what are called the *villi* of the intestines, and pass into the *lacteal*[1] vessels. These gather a milky fluid. Throughout the whole of the smaller intestines, the same operation goes on. The intestinal juice is continually poured out and mixed with the food as it descends. It is more and more digested and exhausted of its nutritious matter, and lacteals continue to convey from it, at every point in its descent, fresh supplies of the milky chyle.

On its way through the lacteals, the chyle undergoes further chemical changes. To promote these changes it is detained here and there by being obliged to pass through several knots or glands, where many of the lacteals meet together, and intermingle their contents. Finally, all the lacteals terminate in the thoracic duct — a vessel which in man is about as large as a goose-quill — and by this duct the chyle is conveyed into the jugular vein. Thence it is forced forward to the lungs, where it assumes a red color, and contributes continually to the formation of new blood.

[1] *Lacteal.*—An absorbent vessel for conveying chyle from the intestines to the thoracic duct.

But besides this absorption of the milky fluid, called chyle, which is conveyed to the blood-vessels by the lacteals, another fluid, to which the name of lymph is given, is also absorbed. [1]Lymph is taken up in minute vessels, which abound in the viscera, and occur to a small extent in the muscular flesh. The lymph in these lymphatic vessels, absorbed from the surrounding juices, passes like the absorbed chyle in the lacteals to the thoracic duct. In this way other nourishing materials, partly of a different kind from those which flow along the lacteals, mingle with the rest of the blood.

When the food has passed through the small intestines and reached the cœcum, the nutritious matter it contains is nearly exhausted in consequence of the different forms of absorption above described. In the colon[2] digestion and absorption do occur, for life may be sustained by food injected therein. A change has taken place, however, in the chemical character of its contents. When the food-pulp escaped from the stomach, it was slightly acid. The admixture of the bile and the other alkaline secretions render it alkaline at about half-way down the smaller intestines. But in the cœcum it becomes slightly acid again, chiefly from the presence of lactic acid and fatty acids due to fermentation and decomposition of fats. The residual food is detained there for some time, that it may undergo a final digestion before its useless residue is altogether discharged from the bowels.

To fix the story of digestion in the mind, we will recapitulate its principal points: The teeth grind the food fine and the tongue mixes it with saliva. This saliva, on the watch to be useful, rushes out and makes the mouth water whenever savory food is spoken or even thought of. It flows most

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[1]The editor again urges upon the reader recourse to some good medical work, to follow on a *cut of the human figure*, this story, point by point.

[2]*Çolon.*—That part of the large intestines which extends from the cœcum to the rectum.

copiously, however, while we chew and while we are digesting. In doing so, the saliva not only moistens the food, but mixes up with it the substance *ptyalin*, which converts its starch into sugar, and is essential to the healthy progress of digestion. Then from the coats of the stomach exudes the gastric juice — also most copiously when there is most work to do. This fluid brings with it the peculiar substance *pepsin*, which renders soluble the gluten of wheat and the fibrin of flesh in the food. When this solution is accomplished, the gastric juice ceases to flow, and the liquid food moves forward to the smaller intestines. Here the sour chyme is mixed with three fluids, which are waiting its approach. A valve opens, and the bile comes out to meet the food — a juice flows forward from the pancreas, like a new saliva — and from the surface of the intestines, as it passes along, a third liquid issues to temper and chemically change it. The chyle, now milky and alkaline, is taken up by the lacteals. These minute vessels are distributed along the whole course of the intestines, extracting, at every step in its progress, new portions or constituents from the food, mixing them all together as the vessels meet in the glandular knots, and pouring the mixture into the one common reservoir — the thoracic duct. And to insure a thorough extraction of all feeding matter, a new change takes place when the food descends into the larger intestine. It becomes acid again, and delivers to the still busy lacteals new materials with which to give the final tempering to the milky chyle as it flows towards the true blood-vessels.

It will amply repay us if we follow a little further the chemistry of this incipient blood.

Seen under the microscope, the milky contents of the thoracic duct have very much the appearance of blood. Numberless rounded discs present themselves, which, by their peculiar granulated appearance, are recognized as the colorless

corpuscles which characterize the blood. As soon as these enter the veins, however, and are thence driven over the lungs, they become colored. By some chemical action in the lungs, they are made to assume a red color, and are no longer distinguishable from the red corpuscles of the blood.

Digestion may now be said to be completed, and true blood is formed.

Such is a sketch of the process of digestion,— of the way in which it takes place — of the complicated apparatus and organs which take part in it — and of the chemical agents which are specially prepared and always ready to assist in it. One long preliminary cooking process goes on from the mouth downwards all the way to the colon, and from every part of this long canal tiny lacteals and absorbing veinlets carry off contributions of cooked food either to the general store of chyle, which is collected in the thoracic duct, or to the venous blood which is hurrying back to the heart. How effectual all this digestion is in exhausting what we eat of its nutritive matter, may be judged of from the fact, that a healthy grown man, fed with ordinary diet, rejects in his solid excreta only about 300 grains of carbon out of the 4,900 grains which he daily consumes in his food, so perfect are the processes of assimilation and combustion which go on in the body!

III. Why we Digest.—This question is, in a certain restricted sense, already answered by the preceding statements. We digest our food that we may prepare materials for the production of blood.

Of what substances, then, does this blood itself consist?

If 100 pounds of human blood be rendered perfectly dry, by a heat not much exceeding that of boiling water, it will be reduced in weight to somewhat less than 22 pounds. It loses about 78¾ per cent of water.

This dry matter consists mainly of the coloring matter called *hæmaglobin*, of albumen, and related substances. It contains a little sugar and fat, and about ¾ of a per cent of saline matter, made up of chlorides, phosphates and sulphates. As blood is so rich in nitrogenous matter, which forms one-fifth of its weight, lean flesh is better adapted for its formation than most kinds of vegetable food.

The blood being formed as the result of the processes just described, what purpose does *it* serve?

The blood serves a double purpose. *First*, it supplies the materials which are necessary to build up and to repair the several parts of the body; *secondly*, it enables the body, without final loss of substance, to discharge the functions on which its life depends.

In closing this chapter on "Digestion," a few points of individual interest, yet not at all irrelevant to the subject, will be added.

THE BLOOD CONTAINS NUTRIENTS FOR BUILDING EVERY PART OF THE BODY.

All parts of the body are supplied from the universally nourishing blood, with the chemical compounds which are specially required for the formation of their own substance, or the discharge of their special functions. Thus the bones require and appropriate phosphate of lime, while the muscles take phosphate of magnesia and phosphate of potash. The cartilages build in soda, in preference to potash. The bones and teeth specially extract fluorine. Silica is almost monopolized by the hair, skin and nails. Iron abounds chiefly in the coloring matter of the blood (*hæmaglobin*), in the black pigment of the eye, and in the hair. Sulphur exists largely in the hair, and an organic compound of phosphoric acid in the brain. Thus, to each part of the body certain chemical substances seem to be most specially appropriated,

and to each part a peculiar and special power has been given of selecting out of the common storehouse those materials which are its imperative need.

THE PROPER BLENDING OF NUTRIENTS.

The natural cravings of the animal appetite for special kinds of food are rich in curious chemical phenomena. The formation of blood, and the maintenance of the animal heat, require the introduction into the stomach of certain chemical forms of matter (gluten, fat, starch, etc.) in certain proportions. The adult man should on the average take for his daily ration not only a certain amount of food-substances (*nutrients*), but he should adjust their relation to one another.

The amount per day may be somewhat as follows:

	lb.	oz.
Water	5	8¾
Albumen, fibrin, etc.	0	4¼
Starch, sugar, etc.	0	11
Fat	0	3¾
Common salt	0	0¾
Phosphates, potash-salts, etc.	0	0⅓

If for a length of time the suitable proportions be disregarded, first the comfort of the body suffers, and subsequently its health. Such changes often proceed slowly, and become sensible only after many years elapse; but the slightest derangements make themselves felt at last, so as seriously to affect the constitutions of whole families and tribes of men.

It is very striking, therefore, to observe how, by a kind of natural instinct, the inhabitants of every country have contrived to mix up and adjust the several kinds of food within their reach, so as to obtain precisely the same physiological end. The Irishman mixes cabbage[1] with his potatoes; the

[1]Cabbage is quite rich in nitrogen.

Englishman, bacon with his beans, or milk and eggs with his starchy foods; the Italian, rich cheese with his macaroni; and the natives of India, gram and other pulse rich in gluten with their rice and millet. These, and other methods mentioned in previous chapters, exhibit so many purely chemical ways of preparing mixtures nearly similar to each other in composition and nutritive value. In the most rude diet, and in the luxuries of the most refined table, the main cravings of animal nature are never lost sight of. Besides the first taste in the mouth, there is an after taste of the digestive organs which requires to be satisfied.

And so with what we call condiments, similar instincts have their play. The wild animals in the central parts of Southern Africa are a sure prey to the hunter who conceals himself beside a salt spring; and our domestic cattle run peacefully to the hand that offers them a taste of this delicious luxury. Yet salt, though often used as a flavorer or regarded as nothing more, is really an essential part of our food,—its sodium supplying that element to the bile, its chlorine furnishing hydrochloric acid for the gastric juice. From time immemorial it has been known that without salt man would miserably perish; and among horrible punishments, entailing certain death, that of feeding culprits on saltless food is said to have prevailed in barbarous times. Maggots and corruption are spoken of by ancient writers as the distressing symptoms which saltless food engenders; but no ancient or unchemical modern could explain how such sufferings arose. Now we know why the animal craves salt, why it suffers discomfort, and why it ultimately falls into disease if salt is for a time withheld. Upwards of half the saline matter of the blood consists of common salt; and as this is partly discharged every day through the skin and the kidneys, the necessity of continued supplies of it to the healthy body becomes sufficiently obvious. The bile also contains soda

as a special and indispensable constituent, and so do all the cartilages of the body. Stint the supply of salt, therefore, and neither will the bile be able properly to assist the digestion, nor the cartilages to be built up again as fast as they naturally waste.

FOR GOOD HEALTH — THE BLOOD MUST BE KEPT ESSENTIALLY THE SAME.

That the blood may subserve its various uses, its natural composition, though continually changing, as I have said, must not be materially altered. It may vary in composition within certain small limits; but when changed beyond these limits, the functions of the whole body begin to be deranged. Hence such a change is carefully provided against.

If, for example, much water is poured into the stomach, the chyle is diluted, the lacteals convey a thin fluid to the blood-vessels, and the blood itself becomes more watery than usual. But instantly to remedy this, the lungs, the skin and the kidneys of the healthy man become more active, the excess of water is carried off, and the blood is thickened again to its usual condition. And so some kinds of food tend to increase the quantity of fat in the blood, others that of albumen, others that of common salt, etc., beyond the average proportion; but the ever-ready removers begin their more active work before any such excess becomes sensible in the healthy man, and continue it till the natural condition is restored.

But the unsleeping activity of the vessels which remove from the blood what it ought nowhere to contain in very sensible proportion, is most remarkably shown by the rapidity with which they carry off those refuse substances which are derived from the natural waste of the tissues. The lacteals are continually conveying new materials to the blood, to rebuild the wasting portions of the body. Of course the

changed substance of the wasted tissues is poured into the blood quite as fast. But so diligent are the vessels and organs whose duty it is to remove this now useless matter, that mere traces of it only can ever be detected in the blood of a healthy man. The kidneys, especially, are on the alert to pick it up, to hurry it away from the blood as rapidly as it appears, and to discharge it by way of the urine. The kidneys are thus the chief cleansers of the vital fluid, so far as its *non*-volatile or fixed impurities are concerned. In immediate importance to life they stand next to the lungs. We may cease for days to carry food into the body without serious injury to life; but let the removers intermit their operations for a single day, and the blood would become loaded with poison, and the animal precipitated into dangerous disease.

WHAT AND WHY WE BREATHE.

To breathe, in the usual acceptation of the term, is to draw in atmospheric air through the mouth and nose into the lungs, and after a brief interval to throw it out again.

The lungs, into which the air is thus drawn, consist of two rounded oblong, somewhat flattened, masses of very cellular substance, situated in the cavity of the chest, and communicating with the atmosphere through the wind pipe or trachea.

The wind pipe as it descends from the throat, branches off into large (bronchial) tubes; and these again and again into smaller, still smaller, and finally into hair-like vessels. Through these the air penetrates into the remotest parts of the cellular substance. Around each *visible* extremity nearly 18,000 cells are clustered.

The cells vary in size; they have a diameter of from one-seventieth to one two-hundredth, or, on an average, of about one-hundredth of an inch. The total number of them is reckoned at 600,000,000! Their walls are very thin; they are mere air-vesicles.

The lungs, as this structure implies, are very elastic, and consequently the volume of air they contain very variable.

At the easy average of 18 inspirations a minute, the bulk of air drawn in and thrown out again amounts to about 18 pints a minute, 1,000 pints an hour, or 3,000 gallons a day.

A word about common air is now in order.

The earth is surrounded by an atmosphere forty-five miles high.

This atmosphere is composed of oxygen one-fifth and nitrogen four-fifths. Carbonic acid and watery vapor are also properties of the atmosphere, but they exist in so slight amounts, as not to be considered in the proportions. To use simple terms, oxygen is the life of the atmosphere and to reduce or counteract its marked exhilarating influence, nitrogen is blended with it.

In oxygen, a candle burns with much greater brilliancy than in common air. Animals breathe it with an increase of pleasure; but it quickens their circulation, throws them into a state of fever, and finally kill them, by excess of excitement.

But in common air, a normal, healthful amount only, of oxygen is found.

Another bit of evidence as to the perfect knowledge and kindly planning of the Creator.

We have previously stated that the human lungs contain about 600,000,000 of cells.

The interior surfaces of all these sells form together an area of about 160 square yards of thin cell-wall! Over the whole of this surface, minute blood-vessels branch out, so as almost entirely to cover it. And along these tiny vessels the blood is continually flowing, and, as it flows, absorbs through their walls the oxygen of the air breathed in. Then the heart is contrived and constructed to keep up this flow. To put the matter plainly, the lungs and the heart working in perfect unison, not only maintain the circulation of the blood, but the oxygen taken in by respiration is sent with the blood to every nook and corner of the system.

Now the oxygen, which thus enters into the circulation, does a vitally important work, viz: It is the means by which that part of the food which has been digested and assimilated, is oxidized or burnt, thus keeping up, as in a steam-engine, the heat and activity of the body.

Let us ask, first, what is the nature of the substances thus burnt or oxidized in the body; then where this combustion takes place; and, lastly, what becomes of the products of combustion — how they are disposed of.

1°. As to the nature of the material which the oxygen of the air, taken into the lungs, combines with and burns, one fact is certain — it is combustible. Now the water and salts which we consume in our food are not combustible; while the starch, the sugar, the fat, the albumen, and other carbon-containing ingredients of our food, are combustible. To these latter compounds we must look for the fuel of the body.

2°. These substances, changed by digestion and absorbed into the circulating blood, which they continually renew, are burnt — that is, oxidized throughout the body. How much of the heat and mechanical energy of the body is derived from the direct burning of the substance of the muscles themselves, and how much from the burning of the combustible constituents ever present in the blood and juice of flesh, has not been determined. But that the oxygen of the air is carried into all parts of the circulation is known. It is carried chiefly in association with the most important constituent of the blood. That constituent is a red substance, *hæmaglobin*, which forms the chief part of the *red corpuscles* of the blood.

3°. But if the carbon-containing substances derived from man's food are burnt throughout his body, and if this burning takes place because of oxygen brought from the lungs, how and in what forms, may we ask, are the products of this burning, being no longer of use, conveyed out of the body?

The very *hæmaglobin* which has brought the oxygen carries away the chief product of the burning — namely, carbonic acid gas. The eight or nine ounces of water, too, which are daily produced by the burning of the hydrogen of the body-fuel, are also mainly removed in the return current of blood,

and discharged from the lungs in the expired air. The waste of all the substances which contain carbon and hydrogen, but no nitrogen, is thus disposed of; but the nitrogenous compounds, which are also burned in the circulatory system, produce something else besides carbonic acid gas and water. The chief of these other products is called *urea*. Not being capable of passing away as vapor, it can only be removed from the blood in a liquid form. It is, in fact, a white crystalline substance, very soluble in water, and is discharged from the body daily, to the extent of about 1⅓ ounce, in the urine. The blood secretes urine into the glandular organs called the kidneys just as it secretes sweat into the sweat-glands of the skin. Thus the solid waste of the nitrogen-compounds of the blood, left when the major part of their carbon and oxygen is burnt, is washed out of the blood and leaves the body chiefly as urea.

Heat must be given off continuously as the starch, sugar, and fat of the food are changed within the body into carbonic acid and water. In this we have the continuous natural source of animal heat. Without this supply of heat the body would soon become cold and stiff. The formation of carbonic acid and water, therefore, continually goes on; and when the food ceases to supply the materials, the body of the animal itself is burned away, so to speak, that the heat may still be kept up. And so a fat animal in good condition can subsist longer without food than a lean one.

But it must be remembered that food, by digestion and assimilation, becomes first of all a part of the body; not till then, does it burn and give rise to heat and motion.

The same truth might be presented in another way. Man eats a large portion of food in order that he may combine it with the oxygen taken in by the lungs, and then breathe it away again as previously described. But before it can be so combined with oxygen, it must be digested and conveyed into

the blood. Thus it may be said with truth, that *we digest in order that we may breathe.*

And as this breathing is continually going on, the blood must as constantly supply the materials out of which the carbonic acid and water may be produced. But that it may do so without lessening its own substance, new streams of chyle must be ever flowing into it, and new food digested, that this chyle may be formed.

When the various nutrients, which dwelt in the digested food, have finally done their work of building tissue and furnishing heat, they are expelled from the body. To make this clear and to impress it upon the mind of the reader and at the risk of somewhat repeating, we give the following:

When the body is in a state of physiological equilibrium, about ninety per cent of all the carbon taken in the food is excreted, in the form of carbonic acid, by the lungs and skin,[1] and about ten per cent in the urinary excreta and fæces. Almost all the nitrogen of the food is excreted in the form of urea within twenty-four hours. The hydrogen is eliminated chiefly in the form of water; the oxygen chiefly in the form of carbonic acid and water. Owing to the oxidation of hydrogen, more water is eliminated than is taken in. The soluble salts are mostly discharged in the urine; the insoluble and less soluble ones (especially those of potash) in the fæces; some pass off in the perspiration.

The sulphur which is contained in albumen is, in part, excreted in the form of urinary *sulphates*, and in part in the fæces, and a small proportion by the skin.

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[1]The breathing process is not wholly confined to the lungs, both the intestinal canal and the skin being associated with the absorption of oxygen and the removal of the carbonic acid gas and water produced by oxidation.

CIRCULATION OF CARBON AND NITROGEN.

This chapter is added because of its practical bearing upon the preceding chapter, and also because the matter presented is of special interest to all students of food.

CIRCULATION OF CARBON.

Carbonic acid gas consists of carbon and oxygen only, and is an essential constituent of our atmosphere. It exists, it is true, only in small proportions in the air. Every 2,500 gallons of air at the level of the sea contain only one gallon of the gas; yet upon the constant presence of this small proportion, the continuance of all vegetable life depends.

All living plants are continually sucking in this gas by their leaves; and the operation goes on so rapidly, that were the entire surface of the earth dry land and under cultivation, crops such as we generally reap from it would extract and fix the whole of the carbon in the form of vegetable matter, in the short space of twenty-two years! And if a flourishing beech-forest covered the whole earth, eight years would suffice to exhaust the entire atmosphere of its carbonic acid gas. Were this to happen, vegetation would cease. But such a catastrophe is prevented by the constant restoration of carbonic acid to the air through the unceasing operation of preservative causes. Thus —

1°. The trees of the forest yearly shed their leaves. Through the influence of the weather these waste portions decay and disappear, restoring again to the atmosphere a portion of the same carbon which the living tree had previviously extracted from it during the period of its growth. The yearly ripening herbage also, and every plant that

naturally withers, on plain or hill — the grass of the burning prairie, and the timber of inflamed forests — with all that man consumes for fuel and burns for other uses;— every form of vegetable matter, in short, when exposed to the action of air or fire, returns, more or less quickly, to the state of carbonic acid, and disappears in the invisible atmosphere. Thus, what is yearly withdrawn from the air by living plants, is so far restored again by those which naturally perish, or which are destroyed by the intervention of man.

2°. But man himself and other animals assist in the same chemical conversion. They consume vegetable food, with the same final result as when it perishes by natural decay, or is destroyed by the agency of fire. It is conveyed into the stomach in the form in which the plant yields it. The green herb, the perfect seed, and the ripe fruit, are eaten and digested; then forthwith they are breathed out again from the lungs and the skin, in the form of carbonic acid and water. But we can follow this operation more closely, and it will be both interesting and instructive to do so.

The leaf of the living plant sucks in carbonic acid from the air, and gives off the oxygen contained in this gas. It retains almost exclusively the carbon. The roots drink in water from the soil, and out of this carbon and water the plant forms starch, sugar, fat and other substances. The animal introduces this starch, sugar, or fat into its stomach, and draws in oxygen from the atmosphere by its lungs. With these materials it undoes the previous labors of the living plant, delivering back again, from the lungs and the skin, the elements of the starch and the oxygen in the form of carbonic acid and water.

The breathing of animals is one of the main sources from which fresh supplies come. The carbonic acid they pour continuously from their lungs and skin, while life lasts, takes the place of that which plants as unweariedly extract from it.

And thus, while the circle of natural operations within the animal is complete in itself, and in every move it makes the animal seems to work only for its own good, it is all the while unconsciously laboring for the benefit of an entirely different order of existences external to itself.

Thus, like the watery vapor of the atmosphere, its carbonic acid also is continually circulating.

From the atmosphere to the plant, from the plant to the animal, and from the animal to the air again — never really the property of any, and never lingering long in one stay,— the whole created carbon is slowly moving in a greater circle between earth and air.

Thus the circle begins with carbonic acid and water, and ends with the same substances. The same materials — the same carbon, for example — circulates over and over again.

CIRCULATION OF NITROGEN.

Gluten is distinguished from starch and fat by containing nitrogen. This nitrogen is the kind of air which forms nearly four-fifths of the bulk of the atmosphere. It exists also in ammonia,— the well-known compound substance which gives their pungent odor to liquid hartshorn and smelling-salts,— and in aquafortis, familiar to chemists by the name of nitric acid. These two compound bodies, ammonia and nitric acid, exist and are formed in the soil, and from the soil these substances are taken up by the roots of plants. In the interior of the plant, these substances are subject to new influences; new chemical changes take place, in which they bear a part; and by means of the nitrogen they contain, gluten is formed. The many intermediate changes which follow each other within the vegetable sap we do not as yet understand; but we do know that the nitrogen which existed as ammonia and nitric acid in the soil, assumes, after these changes, the final form of gluten within the plant.

And now we recall another chemical analogy, to enable our readers to follow this same nitrogen through still further changes. The fibrin or main constituent of the animal muscle, and the white or albumen of the egg, are nearly the same thing in composition and general properties as the gluten of wheat. They all contain nitrogen in nearly the same proportion, and probably in a similar state of chemical combination. When the animal consumes vegetable food, therefore, it introduces into its stomach the very substance of its muscles and blood — the ready-formed materials out of which its several parts are to be built up. It does this, in fact, to build up and renew its several parts by means of this vegetable substance. The gluten of the plant is transformed into the flesh and tissues of the living animal.

Thus the nitrogen of the soil, through the intermedium of the plant, has attained to its highest dignity as a part of the body of breathing and intellectual man.

But having attained this perfect form, the restless elements soon grow weary, so to speak, of their new dignity. Not only is the living body in constant movement as a whole, but all its parts, even the minutest, are in perpetual motion. And so rapid is the tear and wear of the animal machine, to change our figure, in consequence of this incessant movement, that the repairs which are constantly called for have been said to be equal in extent to such as would renovate the greater part of the framework in less than a month. New materials are brought in for the purpose, while the old are thrown away and rejected. Scarcely has the gluten of the plant been comfortably fitted into its place in the muscle, the skin, or the hair of the animal, when it begins forthwith to be dissolved out again — to be decomposed and removed from the body. Restlessness, beyond our control, is thus inherent in the very matter of which we are formed.

The living animal absorbs, as we have seen, much oxygen from the air by its lungs. This inhaled oxygen is, in fact,

the agent through which the change of matter is effected. The muscle, for example, combines with oxygen, and, after several intermediate transformations, is finally changed into substances called urea, uric acid, etc., which pass away through the kidneys. This urea and uric acid return to the soil, from which the nitrogen they contain originally came. There they are gradually converted into ammonia, nitric acid, and other substances such as the plant roots originally took up, and which, now re-formed, are ready again to enter into new roots, and thus to recommence the same round of change.

But the animal does not extract and work up all the gluten of the vegetable food it eats. A part of it escapes digestion, and is rejected in the animal droppings. This mingles with the soil, and there, like the urea, etc., is changed into ammonia and nitric acid. The same happens to the gluten of vegetables which die, and, without entering the stomach, undergo direct natural decay in the air or in the soil. As a result of these changes, the nitrogen they contain is again made to assume those forms in which plants are able to take it up, and to convert it into their own substance.

A view of this circulation of nitrogen is presented in the following scheme :

	Takes in	Produces
THE PLANT	Nitrogen, in the forms of ammonia and nitric acid, from the soil.	Gluten and similar compounds, as albumen.
THE ANIMAL	*a.* Gluten into the stomach in its vegetable food, and oxygen through the lungs.	*a.* Muscle and other tissues.
	b. Animal muscle, etc., into the stomach in its animal food, and oxygen through the lungs.	*b.* Urea, etc., in the liquid excretions.
THE SOIL	Urea, and other animal excretions; dead animals and plants.	Ammonia, nitric acid, and other compounds containing nitrogen.

Thus we end where we began — the soil, the plant, and the animal being involved in one never-ceasing, mutually-dependent revolution. We need scarcely concern ourselves, therefore, for the destiny of the organic part — the tissues and blood of our bodies. Its fate is decided by fixed and unerring laws. When it has served our purpose, new and immediate uses await it.

THE DAILY DIET.

The daily supply of food and the daily waste of the human body have been often made the subject of experiment. It will be understood at once that even with healthy adults the amount of food required will vary according to many circumstances. To begin with, there are peculiarities belonging to each individual; then there are differences in the amount of work performed; the heat or cold of the weather, as well as the condition and quality of the several kinds of food taken — all these things will influence the total quantity of food required in the twenty-four hours, as well as the proportions of the chief components which it should contain. But we may arrive at something like an average daily diet by taking the case of an adult man in good health, weighing 154 pounds, and measuring five feet eight inches in height. Simply to maintain his body, without loss or gain in weight, his ration of food, during the twenty-four hours should, under ordinary conditions, contain at least something like the following:

Nutrients.	In 100 Parts.	Each 24 hours.		
		lb.	oz.	gr.
Water - - - - -	81·5	5	8	320
Albuminoids - - -	3·9	0	4	110
Starch, sugar, etc. - -	10·6	0	11	178
Fat - . - - - -	3·0	0	3	337
Common salt - - -	0·7	0	0	325
Phosphates, potash salts, etc.,	0·3	0	0	170

On adding the figures of the second column together it will be seen that the total daily ration is here assumed to weigh (meat and drink included) 6 lb. 13 oz. 128 gr. Of this amount 1 lb. 4 oz. 245 gr. is actual dry food substance, the remainder, more than 5½ pounds, being water. In reality, the weight of dry food substance eaten will exceed that just named, chiefly for the following reason. We eat our food in the shape of a number of mixed animal and vegetable products, which contain many ingredients besides the water, albuminoids, starch, sugar, fat and mineral salts named above. There is, for instance, always some fibrous material, called cellulose and lignose, in the parts of plants on which we live; there are also present other substances, as coloring matters, which have little or no food value.

These are excluded from the preceding table, but always present in our food. Even in animal food, materials like membranes and connective tissues, are present; but these are not to be regarded as essential or necessary components of a daily ration, as their use in nourishing the body is limited and doubtful.

Were we to mix the pure water, albumen, starch, fat, and salts, shown in our table, together, even in the right proportions, the mixture would not be a perfect food, for it would be wanting in at least one particular—it would not be pleasant in *taste.* Our food should be palatable, that we may eat it with relish and get the greatest nourishment from it. The flavor and texture of food—its taste, in fact—stimulate the production of those secretions—such as the saliva and the gastric juice—by the action of which the food is digested or dissolved, and becomes finally a part of the body, or is *assimilated.* Too much stress must not be laid upon this argument, for experiment has proved that *during short periods* a very simple and monotonous diet has sufficed for all the needs of the body, and has been fully utilized therein even

when it has been eaten with difficulty. But, in general, as it will be allowed that food should be relished, it is desirable that it should be varied in character—it should neither be restricted to vegetable products on the one hand, nor to animal substances (including milk and eggs) on the other. By due admixture of these, and by varing occasionally the kind of vegetable or meat taken, or the modes of cooking adopted, the necessary constituents of a diet are furnished more cheaply, and at the same time do more efficiently their proper work. Now, if we were to confine ourselves to wheat bread, we should be obliged to eat, in order to obtain our daily supply of albuminoids, or "flesh-formers," nearly 4 pounds — an amount which would give us just 32 ounces of the starchy matters which should accompany the 4¼ ounces of albuminoids—or, in other words, it would supply not more than the necessary daily allowance of *nitrogen*, but about one and a half times the necessary daily allowance of *carbon* in the form of starch. Now, animal food is generally richer in albuminoids or nitrogenous constituents than vegetable food; so by mixing lean meat with our bread, we may get a food in which the constituents correspond better to our requirements; for two pounds of bread may be substituted twelve ounces of meat, and yet all the necessary carbon as well as nitrogen be thereby supplied. Another substitution, cheese, which is from one and a half times to twice as rich in nitrogenous matters (that is flesh-formers) as meat, may be, and constantly is, employed with bread as a complete diet, and for persons in health, doing hard bodily work, it affords suitable nourishment. Even some vegetable products, rich in nitrogen, as beans, may be used in the same way as meat or cheese, and for the same purpose.

Such a mixed daily diet as we have been referring to might be furnished by the following foods if consumed in the quantities here given:

		oz.	
1.	BREAD	18	*Altogether these quantities will contain about* 1 *lb.* $5\frac{3}{4}$ *oz. of dry substance, though they weigh in all* 6 *lb.* $14\frac{1}{2}$ *oz.*
2.	BUTTER	1	
3.	MILK	4	
4.	BACON	2	
5.	POTATOES	8	
6.	CABBAGE	6	
7.	CHEESE	$3\frac{1}{2}$	
8.	SUGAR	1	
9.	SALT	$0\frac{3}{4}$	
10.	WATER, alone, and in Tea Cocoa, Coffee	$66\frac{1}{4}$	

It will be seen that the weight of this daily ration exceeds by one ounce — even when the solid matter contained in beverages is omitted — that given before (on p. 84); this excess is mainly owing to the fact, previously mentioned, that in all articles of food actually used there are small quantities of matters (cellulose, etc.) which cannot be reckoned as having a real food value. And it must not be forgotten that the several common proximate principles which can and do supply the greater part of the heat of the body have not all the same value for such a purpose. Of starch and dextrin we should require rather less than of sugar for the production of the same amount of heat and energy, while one ounce of fat or oil will go as far as $2\frac{1}{3}$ ounces of starch. This allows of much variation in our daily food, since we may replace, to a certain extent, a portion of the fat in our rations by its equivalent quantity of starch or dextrin or sugar — or we may diminish the starch and increase the fat. In the former case the dry substance of our food might come to weigh four to five ounces more than the $20\frac{1}{2}$ ounces mentioned before; in the latter case it would weigh less.

Here it may be asked—"Which of the articles of the above mixed diet give the several components of food which we require each day?" A sufficient answer to this inquiry may be

gained by referring to the composition of the several articles of food named, as given in a previous chapter of this book. Here it will be enough to state that the bread consumed supplies chiefly starch, but along with this a good deal of albuminoid substance; the milk gives fat, albuminoids, and a kind of sugar, having nearly the same value as starch; the cheese contains much fat and albuminoid substance; the bacon and butter furnish chiefly fat; while the other articles in the list either give further supplies of these food-components, or else the mineral matter or salts which are required. The first seven articles in the list will likewise contain about 1 lb. 6½ oz. of water, which, with that supplied in various beverages, will furnish the 5 lb. 8¾ oz. daily necessary.

We will recur for a moment to the general nature of the final change which food undergoes in the body. That change, we have before shown, is in the main one of burning,[1] or, as it is called in chemical language, *oxidation*. It is the uniting of certain elements contained in the food — chiefly carbon and hydrogen — with oxygen, brought into the lungs by the act of breathing. The air, then, is, in a sense, part of our food, and forms a large part of the daily in-come of the body.

We now give in a tabular form the daily supply and waste of the human body.

DAILY SUPPLY.

	lb.	oz.	gr.	lb.	oz.	gr.
Oxygen taken from the air breathed -	1	10	115			
Oxygen in starch, albuminoids, and fat	0	7	370			
Total oyxgen - - - -				2	2	47
Carbon in fat, starch, albuminoids - - - -				0	9	400
Hydrogen in the same - - - - - -				0	1	170
Nitrogen in albuminoids - - - - - -				0	0	291
Common salt - - - - - - - -				0	0	325
Phosphates, potash salts, etc. - - - - -				0	0	170
Water - - - - - - - - - -				5	8	320
Total daily supply - - - - -				8	7	410

[1]Chapters on "Digestion"—"What and why we breathe."

DAILY WASTE.

	lb.	oz.	gr.	lb.	oz.	gr.
Oxygen in the carbonic acid gas given out by the lungs - - - - -	1	7	325			
Oxygen in the carbonic acid gas given out by the skin - - - - -	0	0	111			
Oxygen in the organic matter given out by the kidneys and intestine - - -	0	0	357			
Oxygen in the water formed in the body	0	9	130			
Total oxygen in waste - -				2	2	47
Carbon in the carbonic acid gas given out by the lungs - - - - -	0	8	320			
Carbon in the carbonic acid gas given out by the skin - - - - -	0	0	40			
Carbon in the organic matter given out by the kidneys - - - - -	0	0	170			
Carbon in the organic matter given out by the intestine - - - - -	0	0	308			
Total carbon in waste - -				0	9	400
Hydrogen in the water formed in the body, and given out by the lungs and skin	0	1	70			
Hydrogen in the organic compounds given out by the kidneys and intestine	0	0	100			
Total hydrogen found in the water formed and in the organic matter of the waste - - -				0	1	170
Nitrogen in urea and other waste given out by the kidneys - - - - -	0	0	245			
Nitrogen in waste given out by the intestine	0	0	46			
Total nitrogen in waste . -				0	0	291
Common salt given out by the skin - -	0	0	10			
Common salt given out by the kidneys	0	0	315			
Total common salt in waste -				0	0	325
Phosphates and potash salts given out by the kidneys (chiefly) - - -				0	0	170
Water taken in as such, and given out by the lungs, skin, kidneys and intestine, in addition to that formed in the body				5	8	320
Total daily waste - - -				8	7	410

These figures, then, represent the daily balance-sheet of the income and expenditure of a human body—not exactly and perfectly, but with a sufficiently near approach to truth.

All the substances needed for the nutrition and sustenance of the body can be obtained either from the vegetable or the animal kingdom.

There is, however, a considerable difference in there assimilability in the alimentary canal. Albuminates (and fats also) derived from animal sources—as in flesh, eggs, milk, etc.—are almost entirely and rapidly absorbed in the stomach and intestine; whereas the albumen of vegetable substances is generally found in association with relatively large quantities of starch, and these are enclosed in a network of cellulose which is excessively resistant to the action of the digestive juices; and it has been calculated that while only three per cent of the albumen of animal food escapes digestion and is lost in the evacuations, as much as 17 per cent of the albumen of vegetable foods is thus wasted.

It is therefore necessary to consume a much larger quantity of vegetable than of animal food, in order to obtain the necessary amount of nourishment.

It is generally admitted that the digestion of vegetable food is a much more complex process than that of animal food; and we accordingly find the alimentary canal in herbivorous animals to be of far greater extent than in carnivora.

It would seem also that the nutrition of the body undergoes certain modifications, according to the proportions in which animal and vegetable substances enter into the composition of the food. An excess of animal food appears to increase the amount of fibrin in the blood, to add to its richness in corpuscular elements, and to augment the proportion of phosphatic and other mineral constituents; it is also said to confer additional firmness and tone to the muscles, and to lead to the disappearance of superfluous fat. Vegetable food, in

excess, tends, on the contrary, to increase the amount of fat deposited within the body, and to induce obesity.

The urinary excretion is increased in quantity by animal food, and the amount of urea, as is well known, is also increased, together with the phosphates and sulphates. An animal diet tends further to increase the acidity of the urine; a vegetable diet to render it alkaline. Animal food is certianly more stimulating than vegetable food, and appears to satisfy and allay the cravings of hunger more completely and for a longer period.

On the other hand, many of our more troublesome chronic maladies are traceable to the habitual consumption of food too rich in animal albuminates. While the vegetarian can extract from his food all the principles necessary for the growth and support of the body, as well as for the production of heat and force, as before stated, he must select vegetables which contain all the essential elements. He must for this purpose consume the best—wheat, oats, corn, beans, peas, lentils — or he will swallow and digest a large weight of vegetable matter of less nutritive value, and therefore containing at least one element in excess, in order to obtain all the elements he needs. Thus the Irishman requires for his support teh to eleven pounds of potatoes daily, which contain chiefly starch — of which, therefore, he consumes a superfluous quantity — very little nitrogen, and scarcely any fat; hence he obtains milk, or bacon, or fish, to supply the deficiency. The Scotchman, living mainly on oatmeal, requires a much smaller weight, since his grain contains not only starch, but much nitrogen and a fair amount of fat, although not quite sufficient for his purpose, which is usually supplied by adding milk, or a little bacon, to his diet. On the other hand, the man who lives largely on meat and eggs, as well as bread, obtains precisely the same principles, but served in a concentrated form, and a weight of two or three pounds of such

food is a full equivalent to the Irishman's ten or eleven pounds of potatoes and extras. The meat-eater's digestion is taxed with a far less quantity of solid, but that very concentration because of quality, entails in some stomachs an expenditure of force in digestion equal to that required by the vegetarian to assimilate his much larger amount.

We repeat, man can exist, when absolutely necessary, exclusively on animal food, and he can also exist when equally necessary and inevitable, exclusively on vegetable food; but in those parts of the world in which he reaches the highest degree of development and civilization and culture, we find him enjoying a mixed diet, taking a portion of his food from the animal and a portion from the vegetable kingdom.

There are few persons in the present day who advocate the practice of limiting the human dietary to substances of exclusively *vegetable* origin. The majority of the so-called "vegetarians" of modern times adopt no such exclusive diet, but take, together with the more highly nutritive forms of vegetable food, such typical animal foods as eggs, milk, cream, butter and cheese.

As stated at the beginning of this chapter, there are good reasons why no *rule of diet* will be applicable to all cases.

In closing, we will give in plain terms and without detail, what we believe is an excellent *general* rule, for the assortment of the sum total of food for the entire day, viz:

From one-quarter to one-third animal food; the balance to be a blending of fruits, cereals and vegetables.

FOOD FROM INFANCY TO MATURE AGE.

FOOD IN INFANCY AND CHILDHOOD.

When an infant is nursed by a healthy mother, its food for the first seven or eight months of its life should be entirely restricted to the mother's milk. This is the only food that is perfectly adapted, by its characters and composition, to the digestive capacities of the young infant. For some time after birth the salivary glands are not developed and the pancreatic secretion, for the first three months, has no power of digesting starch, so that the young infant is not provided with any means of digesting farinaceous food, even in small quantities, and none should therefore be given. At birth the digestive organs are in a comparatively immature state, the alimentary canal is short and the cæcum very small.

During the first six weeks the child should be put to the breast every second hour from 5 A. M. to 11 P. M. It should be removed from the breast as soon as it shows an inclination to discontinue sucking; and it should be remembered that at birth the child's stomach is of very small capacity, and the breast should never be forced upon it, so long as it sleeps well, and thrives well, and is content.

Feeding every three hours will be often enough, with many children, after the third week, and up to the end of the second month. It must be remembered that these, as well as the periods to be subsequently stated, are only average intervals, useful for general guidance, but which may need modification according to individual peculiarities, some infants feeding much more eagerly than others, and taking more at a time. From the second to the seventh or eighth month the infant should be suckled every three or four hours.

The composition of human milk varies somewhat, according to the period of lactation and other circumstances. After delivery, for the first few days, it is of greater consistence, and of a yellow color, and is known as *colostrum.* It contains large cells filled with fat granules termed colostrum corpuscles. The regular secretion of milk begins after three or four days. The casein and fat increase in quantity up to the end of the second month, the salts up to the fifth month, and the sugar from the eighth to the tenth month. The greater the quantity secreted, the more casein and sugar and the less fat it contains.

The diet of the mother, no doubt, influences somewhat the composition of the milk, especially as to the amount of fat it may contain. It should be simple, nutritious, ample, and regular. Rich and stimulating foods should be avoided. She may be permitted, for the purpose of increasing the flow of milk, the free use of animal broths, chocolate, milk, and gruel.

Oatmeal porridge at breakfast is excellent, and tends to obviate the constipation that often attends this period of relative physical inactivity.

Fortunate is the babe that, in our day of advanced civilization and city-living, can draw from the breast of a robust mother an abundant supply of pure, health-giving, tissue-building food. In such a case the child should be nursed *solely* by the mother up to eight months, and after that *partially* to the end of the first year, if possible.

The date of weaning must depend, to some extent, on the health of the mother and the development of the child. If both are doing well between the tenth and the twelfth month, the breast should gradually be withdrawn.

After the seventh or eighth month, when the teeth begin to appear and the salivary glands to be developed, some other food may be introduced, once or twice a day, instead of the breast-milk.

Some of the well known prepared foods — being in readily assimilable form — will meet the want.

Mutton broth or jelly made from the shank of mutton is also admissible. But after weaning, and up to a year and a half, milk should still be the chief article of diet.

A little custard pudding may also be given daily, made by mixing one egg with half a pint of milk, and adding a little sugar.

The egg usefully supplies a certain amount of albuminates and fats.

After eighteen months the following articles of diet may be gradually and occasionally introduced:

A little finely pounded chicken, mutton, or beef, and especially mutton *fat*, which may be pounded and mixed with a little mealy potato, and a little rare meat gravy added to it.

Mashed potato and cauliflower carefully passed through a sieve may also be used, as well as stale bread-crumbs, soaked in milk or broth.

As soon as the teeth are fully developed some food requiring mastication should be given.

The foregoing dietary applies to a healthy child brought up by a healthy mother on breast-milk.

There are many cases where the mother cannot supply the food.

The statement is a bold one, and seemingly contrary to nature, that, taking the average, infants properly brought up by hand are better developed and enjoy more perfect health than those completely breast-fed. Of course, there is no artificial food equal to the natural—the sound breast-milk of a robust woman—and a child fed upon this must thrive, if other circumstances are favorable. Unfortunately the woman who has sufficient health and strength to furnish an abundant supply of good milk during the ten or twelve months of normal lactation, is unique, in our day, and the great bulk of those

who do nurse children, grow pale, thin, and feeble, and give milk which, though sufficient in quantity to fill the suckling's stomach and satisfy the craving of hunger, does not contain enough pabulum to meet the demands of nutrition. Such mothers always complain that their children are puny, peevish, and always ailing, and wonder why their neighbor's babies fed upon the bottle are so round, jolly, and healthy. The explanation lies in the fact that good cow's milk, or a good so called artificial food, is better than bad breast milk.

An important point is the *quantity* of food that should be given to an infant brought up by hand. It must of course vary with the age and appetite of the child, but it must be remembered that too frequent feeding is liable to set up gastro-intestinal catarrh. A good practical rule is to let the infant take as much or as little as it likes, *provided it thrives!*

DIET FROM EIGHTEEN MONTHS TO TWO AND A HALF YEARS.

1st meal, 7 a.m.—A breakfastcupful of new milk, the yolk of an egg lightly boiled, 2 thin slices of bread and butter.
2d " 11 a.m.—A teacupful of milk with stale bread.
3d " 2 p.m.—A breakfastcupful of beef-tea, mutton or chicken broth; a slice of whole wheat bread; a saucer of rice and milk pudding.
4th " 6.30 p.m.—A breakfastcupful of milk with bread and butter.

AS AN ALTERNATIVE DIET.

1st meal, 7 a.m.—Two tablespoonfuls of thoroughly-cooked oatmeal or wheat grits, with sugar and cream; a teacupful of new milk.
2d " 11 a.m.—A teacupful of milk, with a slice of bread and butter.
3d " 2 p.m.—One tablespoonful of rare mutton, pounded to a paste; bread and butter, or mashed baked potato. moistened with good plain dish gravy; a saucer of junket.
4th " 6.30 p.m.—A breakfastcupful of milk, a slice of soft milk toast or a slice or two of bread and butter.

If these diets at any time disagree, return to a plain milk diet, or the prepared food.

The preceding tables must only be taken as indicating averages. Many children thrive best on a purely milk diet, or in connection with some of the prepared foods, up to the age of two or two and a half years. When a child is thriving and content on a given diet, be in no haste to alter it.

It should not be forgotten, as is sometimes the case, that a child, however young, occasionally requires, and is better for, a drink of water. Pure water, not too cold.

The most scrupulous cleanliness must be observed with regard to all the vessels containing the infant's food. Each meal must also be prepared at the time it is wanted, and not taken from a stock on hand. The temperature of the food of young infants should be about 95° F.

It is also most important, unless the source of the milk supply is absolutely above suspicion, that all milk used for feeding infants should be *boiled* or *sterilized.*

Children who have cut their milk-teeth may be fed for a twelvemonth—*i. e.* up to the age of three and a half years—as follows:

1st meal, 7 a.m.—One or two tumblerfuls of milk, a saucer of thoroughly cooked oatmeal or wheat grits, and a slice of bread and butter.

2d " 11 a.m.—(If hungry.) A tumblerful of milk, or a teacupful of beef-tea, with a biscuit.

3d " 2 p.m.—A slice of underdone roast beef or mutton, or a bit of roast chicken or turkey, minced as finely as possible; a baked potato, thoroughly mashed with a fork, and moistened with gravy; a slice of bread and butter; rice and milk pudding.

4th " 7 p.m.—A tumblerful of milk, and one or two slices of well-moistened whole-wheat milk-toast.

For the rest of childhood, a chief point is to see that the child does not eat hastily, but masticates his food leisurely.

The diet should be plain, but varied, and the following lists of suitable dishes from which to select may serve as a convenient guide:

BREAKFAST.

Daily.	*One dish only each day.*
Milk.	Fresh fish.
Porridge and cream.	Eggs, lightly cooked.
Bread and butter.	Chicken hash.
	Grilled fat bacon.

Thoroughly ripe sound fruit may be allowed with this meal in small or moderate quantity.

DINNER.

Daily.	*Two dishes each day.*
Clear soup.	Potatoes, baked and mashed.
Meat, roasted or broiled, and cut into small pieces.	Spinach.
Bread and butter.	Stewed celery.
	Cauliflowers.
	Hominy.
	Maccaroni, plain.
	Peas.
	Beans.

Rice and milk, or other light pudding.

SUPPER.

Daily.

Milk.
Milk-toast, or bread and butter.
Stewed fruit.

As to quantity, if a child eats slowly and masticates thoroughly, he may generally be trusted to satisfy his appetite at each meal. Fried food and highly-seasoned dishes should be avoided. Salt, but no other condiment, should be allowed, and pure water should be the only drink.

FOOD DURING SCHOOL LIFE.

Assuming that the period of school-life extends, on an average, from ten to eighteen years of age, it is scarcely necessary to say that this is one of the most critical and most important epochs in the life of the individual as regards sufficient and adequate nutrition. It is a time of active growth and development both physical and intellectual, and it is a time when any serious check to the perfect and complete evolution of the organs and functions of the body may lead to ineradicable mischief, and severely handicap the individual in the subsequent "struggle for existence."

Those who are entrusted with the care of the young of both sexes during this period are, perhaps, sometimes apt to regard with too little attention and interest the *physical* development of those under their charge, and this from a too great eagerness to promote their intellectual culture. It should be remembered that the education of the mind is, and should be, a *lifelong* process—there is no need of hurry, but that the development of the body is strictly limited to a certain period of existence, and becomes finally and irrevocably arrested at a given date.

It should, then, be ever present in the minds of those who undertake the education of youth that they are in a special and peculiar way responsible for their physical growth and development, and that these cannot proceed satisfactorily without a careful and intelligent arrangement and supervision of their food. And not only is this period of life one of continuous growth and development; it is also one of remarkable physical activity. So that there is a constant and twofold demand for appropriate food—the demand of the growing organs, and the demand connected with muscular activity and mental training. At no period of life is it so necessary to be provided with a complete and liberal dietary.

Provision should always be made for some plain and wholesome food, such as bread and butter, or bread and cheese, to be accessible to the hungry boy or girl at other than the ordinary meal-times. The rate of growth in any individual cannot be controlled or regulated by general rules, and when this is taking place with exceptional rapidity, exceptional quantities of food are needed.

The diet through the school age must not only be abundant in quantity; it must also be suitable in quality. It must contain a proper proportion of *albuminates*, to minister to the growth of the muscular and other tissues; it must contain *fats* and *starches*, for the development of heat and muscular energy, and the former is an important agent in tissue-growth; and it must contain the necessary proportions of mineral substances to furnish the materials necessary for the growth and consolidation of the hard tissues, as the bones and teeth, especially phosphates of lime.

Some practical suggestions regarding the diet of boys and girls at Boarding School, will be given.

It is undesirable, especially with the younger and less robust pupils, that they should be given any task before breakfast. The practice of preparing a lesson at 7 A. M., on an empty stomach, and after a long fast, especially in winter, is indefensible.

At 6.45 to 7.15 a. m. there should be a provision of hot cocoa or coffee, with plenty of milk—beverages both nutritious and stimulating.

At 8.30 a. m.—Breakfast, after the first lesson; this should be a good meal, with some animal food—ham, bacon, cold beef, fish, or eggs. Some porridge. Bread and butter, with jam or marmalade. Hot milk and water, or cocoa.

At 1.30 p. m.—Dinner, which should be a good meal of meat, pudding, potatoes or green vegetables, or beans, with simple dessert.

5 to 6 p. m.—Milk, bread and butter, with marmalade or jam, an egg, or potted meat.

Water-cress, lettuce, celery, or other fresh salads might be served at this meal or at supper.

Or instead of a meal at 5 or 6 P. M., only a few hours after a heavy dinner, it would perhaps be better to serve simply weak tea, cocoa, or hot milk and water at that hour, and provide a fairly nutritious, but unstimulating supper at 7 P. M. Porridge made with milk would be excellent; or tapioca, or rice pudding, with marmalade, or bread and butter with some salad or fruit, or, in winter, some good soup with bread or other farinaceous substance, or any other light, but nutritious food.

As to different articles of diet; the bread should be whole-meal bread. This is no doubt the best bread for growing children and young people. There is little risk of their not being able to digest it, and it is certainly richer in the mineral substances they especially require than fine white bread. But what is of far more importance is that the bread should be well made — that it should be good and palatable, not sour, sticky, or musty. The allowance of bread should not be limited, and butter should be given with it, as wheat bread is deficient in fats.

Farinaceous and saccharine foods should be freely supplied as heat and force-developing foods, and as more digestible than fats.

Milk should be abundantly provided for all adolescents as an essential part of their regular diet. It contains all the necessary elements of food in a readily assimilable form, and is particularly fitted for nourishment during rapid growth. When there is any possibility of its serving as the medium of the conveyance of disease, it should be boiled before consumption.

Meat should be provided twice a day — at breakfast and dinner — during the time of active growth. This may be in the form of beef, or fish, bacon, sausage, eggs, etc.

Monotony should be avoided, and more effort should be made to give variety to the food provided at different meals.

Fish should be more largely utilized, and a *fish day* once or twice a week, in places where a good supply of fresh fish is available, should be instituted.

Attempts should be made to overcome any distaste that exists for green vegetables. They should be cooked and served in a more attractive form; or soup with plenty of vegetables should be given once or twice a week in winter. This is of much importance, as eczema is prone to appear at school if pupils are kept on a too exclusively animal diet.

Thus an albuminous diet, together with nitrogenous farinaceous foods and fish, and an abundant supply of oxygen and an open air life, supplies all that is required.

FOOD IN ADULT LIFE.

It has become an almost universal custom in civilized life to appropriate certain fixed times in the day for taking food. Not only does this practice appear to be well suited to our physical organization, and therefore most consistent with health, but it is obviously a necessary condition of a life full of physical and intellectual activity and occupation, such as the great majority of civilized human beings lead.

Reference has been made by various authors to the habits of feeding of other animals, and attention has been directed to the long periods during which the carnivorous animals are accustomed to go without food as compared with the almost continuous feeding of some of the herbivora. But none of these animals in their natural state lead an existence at all analogous to that of civilized human beings, and when such herbivorous animals as the horse or the ox are applied to the service of man, the same mode of feeding, viz., at regular, fixed intervals, is found to suit them perfectly well. The carnivorous animal usually consumes an enormous quantity of food, if he can obtain it, at each meal and then passes into a condition of torpor and lethargy, and the human being who

attempts to imitate his habits of feeding will be found to be affected with the same kind of languor and incapacity for exertion after meals.

In fixing the intervals which should occur between meals, it is necessary to bear in mind that the rate of digestion varies considerably in different persons and at different ages, and that it is also greatly influenced by habits and occupation.

It has been estimated that it requires from four to five hours to digest an average meal; but some meals and certain kinds of food require a longer time than this, while for some kinds of food a shorter period is sufficient. In a growing active youth or a healthy child, fed on appropriate and readily digested food, the digestive process is comparatively rapid, and the intervals between meals should therefore be shorter than in the case of adults. So also in adults leading an active out-of-door life, the food taken at each meal will be digested more rapidly and more completely than in the case of persons of middle age following a sedentary occupation.

The tendency, no doubt, is to eat at too short intervals, and in many cases indigestion arises from the stomach being frequently called upon to commence the digestion of a fresh meal before it has completed that of the preceding one.

The first meal of the day is *breakfast*, and it is a very important one. In the case of active persons leading wholesome, regular lives, it should be taken as soon after rising as possible. Persons who require to take exercise before breakfast are either dyspeptic or overfed; and, except in such persons, any considerable exertion, without having first taken food, after so long a fast as usually occurs from the preceding meal, is unduly exhausting and calculated to be injurious.

The unfed organism at this period of the day is also very susceptible to morbid influences, and especially prone to take harm from exposure to cold, to infection, or other injurious and depressing agencies.

The quantity and kind of food proper to be taken at this meal must depend on what may be the custom with regard to the food taken at luncheon, or at an early dinner. Those who take a substantial meal in the middle of the day do not require a large breakfast; a cup of tea, coffee, or cocoa, with a little bread or toast and butter, a boiled or poached egg and a rasher of bacon, is ample in this case. But when only a very light luncheon is taken between breakfast and late dinner — a plan which suits many busy professional and business men exceedingly well — then the breakfast should be as substantial as the appetite and digestion are equal to.

With a substantial breakfast, and a good vigorous digestion, the organism is well furnished to begin the work of the day, and only a very light luncheon will be required. This should consist of a mutton chop, or a little cold chicken, with bread or a potato, or a small plate of good soup with a little toast. Nothing more! Half-past 12 or 1 o'clock is a good time for such a meal.

Those who take a light breakfast, and find it convenient to dine in the middle of the day, must, if they are engaged in active intellectual work in the afternoon, be careful not to make a large meal at this hour, as it is almost certain to make them heavy and dull for an hour or two afterwards.

An early dinner of this kind should consist simply of a chop or steak, or a cut or two of some good roast, hot or cold, with a small quantity of bread and vegetables, a little bread and cheese, or butter; or, if preferred, a little light pudding or some cooked fruit.

A substantial dinner at 6 or half-past is appropriate for those who lunch lightly. It should consist of soup or fish, or both, an entree, or some roast, poultry or game, according to choice; some cooked fruit or light pudding, biscuit and cheese, and fresh vegetables and salads of the season.

Those who take a mid-day dinner should take a light supper about half-past six or seven : a little fish, or chicken, ham, or other cold meat and salad, with a little bread and cheese or butter.

Considerable variations in the manner, frequency, and time of taking meals appear to be not inconsistent with health.

The above are general rules — not specific.

The order of the courses at dinner, *i. e.* of soup, fish, entrée, roast, and sweets, cannot well be improved upon. Soup at the *beginning* of dinner has been objected to on the ground that it diminishes digestive power by diluting the gastric juice, and this objection is valid if a *large* quantity of badly-made soup is taken. But it does not apply to a small quantity, four to eight ounces, of well-made clear soup. Such a fluid disappears quickly on reaching the stomach, as it is rapidly absorbed by its blood-vessels and interferes in no way with the gastric juice. Its value at the commencement of a meal depends on the fact of its rapid absorption and entrance into the blood, so that the hungry man is quickly refreshed. Soup introduces at once into the system a small installment of ready-digested food and saves the period of trial, which, in the absence of soup, must be spent by the stomach in deriving some portion of nutriment from solid aliment, and thus the organ of digestion itself is indirectly strengthened for its forthcoming duties; by filling the vessels of the stomach itself it really assists in the secretion of the gastric juice. A certain interval should be allowed to elapse between the last meal of the day, whether it be called dinner or supper, and the time of going to bed. The functions of the body pass into a state of inactivity during sleep, and all the organs of the body should "rest from their labors." If the chief work of the stomach is not completed or nearly completed on retiring to rest, that rest is likely to be imperfect or disturbed. An hour and a half or two hours is sufficient to allow between a light

supper and bed time, but at least two and a half or three hours should elapse between a heavy dinner and retiring to bed. It would be an error, however, to suppose that a perfectly empty stomach contributes to repose ; on the contrary, it frequently is the cause of wakefulness. A certain sense of repletion, a sense of all the wants of the body being completely satisfied, conduces greatly to repose ; this is strikingly manifested in the tendency shown by nearly all animals to fall asleep after a full meal. Many persons who of necessity retire to bed late, and who do not dine very late or eat very largely at dinner, find that they sleep much better if they take a cupful of clear soup with a little toast or a large cup of hot cocoa, before going to bed.

It is scarcely necessary to say that the habit of taking food between meals, or other than at the stated meal times is most injudicious and hurtful.

A meal should not be commenced immediately after active or violent exercise. The half-hour devoted to leisurely dressing for dinner—and after violent exercise half an hour's perfect rest before this — is the best preparation for the principal meal of the day. The stomach requires to have at its disposal the best and freshest energies of the body for its important work — the work, it must not be forgotten, upon which every other energy and function of the body is absolutely and entirely dependent. For the same reason violent exercise after a meal is to be carefully avoided.

Adults whose lives are necessarily and chiefly devoted to *intellectual* or other sedentary occupations should not attempt to consume the same amount of food as those whose duties or pursuits involve much physical activity in the open air. The kinds of food they take may also frequently be modified with advantage. The substitution of fish, to some extent, for meat has much to recommend it in these individuals. It is not so rich in nitrogenous substances as meat, and does not

throw so much work on the eliminating functions; and the lighter kinds are much easier of digestion. There is, however, no foundation for the popular view that fish contains elements which adapt it in a special manner to be a "brain-food" or to sustain and promote intellectual labor.

Brain-workers should live much on light food not demanding much effort of the stomach to digest, and they should remember that the digestion of heavy meals involves also a greater expenditure of nerve-force. Besides fish, eggs, milk, light porous *well-made* bread, fresh vegetables and fruit should form their chief sustenance. They should take only a small amount of meat, and that especially on those occasions when they are able to take more physical exercise. Some animal fat is, however, useful, such as fresh butter or cream, or a rasher or two of fat bacon at breakfast. It is a remarkable fact that whereas the muscles contain only three per cent of fat, the brain contains eight per cent, and the nerves twenty-two per cent; and this high percentage of fatty matters contained in nervous substances indicates the necessity of fat for the proper performance of the functions of the nerves.

Climate and temperature, as well as physical activity, influence also the quantity and quality of the food required.

It is well known that in tropical countries, as well as in countries where they have prolonged *hot* seasons, the natives live much on vegetable foods and fruit, when these can be obtained, and consume little animal food and fatty substances. Whereas in Arctic regions, where no vegetables can be obtained, the inhabitants consume enormous quantities of animal flesh and fat. The necessity of supplying the body with a large proportion of combustible food, such as hydro-carbons, when the external temperature is very low, is obvious; and it is equally clear that very little food of this kind is needed when the external temperature is high. During the heat of summer some modification of the habitual diet should be made;

less animal food and fats should be consumed, and more vegetable substances and fruit should be taken in their place.

Many *idiosyncrasies* with regard to particular articles of food have to be considered, not only in adult life, when, however, they become more marked, but at all ages. Some persons cannot digest milk, others cannot take eggs in any form: some can eat no fat; some are made ill by certain kinds of fish, etc. All these peculiarities have to be reckoned with. These are sometimes due to inherited tendencies; sometimes they are the growth of habit.

Some persons do best with long intervals between their meals; their digestions are slow. Others with quick digestions require food more frequently. Long fasts are, as a rule, ill borne by feeble persons who cannot eat largely at their meals, and such persons are often better for taking a small quantity of food between their late dinner and breakfast, which usually involves a fast of twelve or more hours. A little light food on going to bed, or, if they wake, as they are prone to do, in the night, is advisable. This may be simply a cup of clear soup, or beef-tea, or gruel, milk, or arrowroot.

It is to be noted also that *women* require less food than men, as their bodies are usually smaller, and they more commonly lead inactive, sedentary lives.

They, however, pass through critical periods, which may require special care; *e.g.* after repeated profuse hemorrhage at the menstrual periods, they may require a diet rich in albuminates to repair the losses caused thereby. Also especial provision should be made in the dietary for the special calls upon the system which pregnancy and lactation involve.

FOOD IN ADVANCED AGE.

With advancing years the functional activity of the bodily organs diminishes, the capacity for physical exertion is con-

siderably weakened, and the mental powers usually begin to flag; the functional activity in the digestive organs partakes in this general decline, so that while there is less need for food on account of lowered physical and mental activities, there is also less power of digesting and assimilating food on account of the slowly progressing degenerative changes in the secreting glands and the consequent diminished digestive and absorbent power in the alimentary canal. The circulation through the abdominal organs also tends to become languid, so that absorption is thereby delayed, and may be further hindered by degenerative changes in the blood-vessels themselves. Moreover, the muscular walls of the intestine lose their tone and contractile power, and there is a tendency to dilatation, especially of parts of the large intestine, causing delay in the expulsion of the residual fæces, so that constipation and flatulence tend to add further to the embarrassment of the digestive functions.

All these inevitable changes necessitate appropriate and corresponding changes in the amount and kind of food taken.

In the first place, the food must be diminished in quantity. Less nutriment must be taken in proportion as age advances and activity diminishes, otherwise fat will accumulate or symptoms of gout or rheumatism, or other troubles depending on defective elimination, will make their appearance, and may be regarded as danger-signals. The "intake" must be reduced, because a smaller expenditure is an enforced condition of existence. The system of giving aged persons increased quantities of food and stimulants, is an error of cardinal importance, and without doubt tends to shorten or to embitter life. As age increases the ability to eliminate food unnecessarily consumed notably diminishes. The elderly man who desires to preserve fair health and to attain to longevity should gradually diminish his use of strong nitrogenous and much fatty food.

It has been pointed out by several writers that the disappearance of the teeth in advanced life and the loss thereby of the powers of mastication seem to be associated with the fact that food needing mastication, such as animal flesh, are inappropriate to this period of life, and that the softer and lighter kinds of food not needing mastication are more suitable and should be had recourse to. It is true that the dentist's art is capable of replacing the lost masticating organs, but if these artificial teeth are used for the purpose of continuing a diet largely composed of animal flesh, they will not prove an unqualified advantage.

The typical man of eighty or ninety years, still retaining a respectable amount of energy of body and mind, is *lean and spare*, and lives on slender rations.

Great caution, however, should be observed in making any radical change in the diet of an elderly person, and it should be introduced very gradually.

The proportion of animal to vegetable food should not be more than one part of the former to three of the latter, and it should be our aim to reduce even this proportion. As the amount of food taken at one time should be small, it is necessary, at this period of life, that the intervals between meals should be somewhat shortened, and the meals, therefore, more numerous. It is often an advantage, for this reason, for aged persons to have a little fluid food at hand during the night, to be taken when they awake, as they so often do, about three or four o'clock in the morning. A little food or stimulant taken at this hour will frequently enable them to fall asleep again.

Large heavy meals must, then, be carefully avoided, and meals consisting of a small or moderate amount of easily-digested food should succeed one another at not too long intervals.

Of the animal foods best suited for this time of life, the

following may be mentioned. When the organs of mastication are altogether inefficient, these foods should be minced or pounded into a paste, or otherwise finely subdivided:

Young and tender chicken and game, and other tender meats.
Potted chicken, game and other meats. Sweetbread.
Fish. Best when boiled.
Bacon, broiled; eggs lightly cooked, or beaten up with milk, etc.
Nutritious soups, beef tea and broths.
Milk in all forms when easily digested.
Beef-tea and milk supply the needed mineral substances, and the former is an excellent stimulant.

Of vegetable food the following are all suitable:

Bread-and-milk made with stale bread.
Porridge and oatmeal gruel.
Puddings of ground rice, tapioca, arrowroot, sago, macaroni, with milk or eggs, and flavored with some warm spices, or served with fruit-juice or jelly; bread and butter, the bread at least a day old.
Artificial foods, consisting of pre-digested starches.
All farinaceous foods should be submitted to a high temperature for some time, so as to render the starch granules more easy of digestion.
Vegetable purées of all kinds may be taken in moderation, *e.g.* potatoes, carrots, spinach, and other succulent vegetables.
It is important that the use of potatoes and fresh vegetables should not be neglected, otherwise a scorbutic state of the body may be engendered.
Stewed celery and stewed onions.
Stewed or baked fruits and fruit jellies, and the pulp of perfectly ripe raw fruits in small quantities.

The acidity of certain stewed fruits may advantageously be neutralized by the addition of a little bicarbonate of soda, so as to avoid the use of a large quantity of cane-sugar to sweeten it, as this is apt to cause gastric fermentation and acidity. In stewing fruit, about as much soda as will cover a twenty-five cent piece should be added to each pound of fruit.

FOOD ADULTERATION.

Food Adulteration is an ever-increasing menace to our people.

We believe this statement is not the sneer of the pessimist, but only a common sense verdict on the evidence submitted, and where the counterfeit used is deleterious to health, as it often is, this practice sinks into so positively dangerous an act as to be malicious and criminal.

To bring the matter to a focus we will enumerate some of the food products most liable to be adulterated. In cereals and bread stuffs we will only mention graham. Besides graham, which is the whole wheat ground, is flour made from the entire kernel, minus the bran or outer husk. But, for illustration, we use the general term graham in contradistinction to white flour, and pronounce it in every way superior; yet a large part of the so-called graham is not graham at all, but simply a mixture of cheap flour and shorts. As the genuine is good, so is this counterfeit lacking in goodness. Not poisonous, but wholly neutral, doing no good, giving to the system not one atom of strength. This kind of graham is usually offered to those consumers with whom price and not quality is a prevailing argument.

Not many years since a case happened in Boston, where, after careful examination by chemists from Harvard University, molasses, by the hogshead, was found containing salts of tin and other poisonous decoctions, mixed with the molasses

to change it to a lighter color, and thus bring a low grade up to where the price of a high grade could be obtained, although its real quality remained unchanged except for the worse.

Where one such case comes to light a thousand cases remain undiscovered. Where adulteration is practised, it is done with great dexterity and every caution is used to guard against the consumer's knowledge.

It is often said by interested parties, that many of the adulterants used in foods, are perfectly harmless ; that they are employed as substitutes because of their lower cost.

Our answer is that adulteration even if not harmful to the system or dangerous to life—in very many cases it is the former and therefore indirectly the latter—has the opprobrium of being basely deceptive and fraudulent.

In everything, but especially in Food Products, let the name on the package honestly represent its contents. If adulterants are used to cheapen the cost, let the label so state and the package be sold at the lower price.

As it now is, we fear the manufacturer rather than the consumer profits by the substitution.

The principal articles which are found to be adulterated are milk, butter, lard, olive oil, vinegar, cream of tartar, spices of various kinds, especially pepper, molasses, syrups, honey, jams, jellies, coffee and sometimes tea, and flavoring extracts —especially vanilla. The prevalent adulterant for the latter, is the poisonous tonqua bean.

Cheap confectionery, molasses, syrups, honey, jellies and jams, are largely adulterated with glucose. There has been considerable discussion whether or not glucose is harmful. Some medical journals have stated that it is.

On the other hand, it is claimed that while in the manufacture of glucose injurious chemicals are employed, such as sulphuric acid and lime, these do not exist in the product sufficient to cause any harm, and that objection to the use of

glucose lies wholly in its substitution for an article of greater commercial value. Glucose is made from starch by the action of dilute acid, and is very generally used as an adulterant. In form, glucose comes both as a solid and a clear, transparent syrup. It has much less sweetening power than either cane sugar or syrup.

Some reliable statistics, will now be presented, taken from the Twenty-Second Annual report of the Massachusetts State Board of Health:

The number of samples of food examined during the year was 5,585, which was larger than that of any previous year.

The following summary presents the classified statement of the work done.

Number of samples of food examined	5,585
" " " found to be pure	3,771
" " " adulterated, or not conforming to the statutes	1,814
Percentage of adulteration	32.5

The following list comprises the articles of food, exclusive of milk, which were obtained by the inspectors during the year and were submitted to the analysts of the Board for examination:

Vinegar, 183. One hundred and thirty-one were above the standard, and fifty two were deficient in acidity or residue or in both. A few of the adulterated samples were white wine vinegar colored with caramel.

Cream of tartar, 194. Twenty-five samples contained one or more of the common adulterants,—corn starch, rice flour, alum, calcium sulphate, acid phosphate, etc.

Molasses, 431. Seventy samples were adulterated with corn glucose in varying amounts. The remainder were genuine.

This is a better report on this article than was rendered by the previous annual report, which said:

"Seven samples of molasses were contaminated with poisonous salts of tin, added for the purpose of improving the color, and to produce a fictitious value."

Black pepper, 151. Thirty-five were adulterated.

White pepper, 26. Six samples were adulterated.

Ginger, 72. Seven samples were adulterated.

Mustard, 62. Twenty-three were adulterated.

Cloves, 135. Eighteen were adulterated.

Cayenne, 19. Three were adulterated.

Mace, 12. Two were adulterated.

Cassia, 144. Eight were adulterated.

Allspice, 64. Two were adulterated.

Canned foods, 17. These included one sample each of asparagus and peas and fifteen of condensed milk. One sample of the latter contained slight metallic contamination; all the others were of good quality.

Cocoa, 8. Four contained wheat flour.

Olive oil, 22. Ten proved to be an inferior substitute, or olive oil containing a small amount of cotton-seed oil.

Baking powder, 11. All of these contained alum.

Coffee, 21. Three consisted wholly of roasted cereals.

Maple Syrup, 21, and *Maple sugar*, 18. Thirteen of the former and four of the latter were found to be adulterated with glucose or brown sugar.

Honey, 27. Eleven were adulterated with glucose.

Sugar, 22. Two contained borax. Additional samples from the same source were found to be pure.

Lard, 21. Six samples were adulterated with cotton-seed oil and stearine.

* * * * * * *

In conclusion shall we give our readers a practical word? If so, let us consider, briefly, three helps which together will prove an effective remedy for this evil.

First. Unremitting work on the part of the people until restrictive and prohibitory laws are made and enforced.

Second. Intelligence on the part of consumers regarding food products, and putting that intelligence to a practical test when making their purchases.

Men have a distinct, individual character by which they are known and rated. The same is true of institutions of finance; the same is true of the different makes of food products.

Every one knows it is easy to so invest money as to lose it. Every one also knows it is possible by exercising intelligent prudence to so invest money as to insure about absolute safety.

Apply this rule to manufactured food products and every household is safe.

Third. Train the boys to be honest. Let them understand it is not only the best policy, but that it is the only policy because it is right. Let them be trained to consider that life an utter failure whose possessions were gained by other than downright, sterling, old-fashioned honesty. That the millionaire, whose wealth was accumulated by questionable methods, is poor indeed; while he of meagre purse and modest life, if his heart be right and his conscience clean, has riches that are sure and ever abiding.

Many things may contribute to winning in this fight for pure goods, but we are fully persuaded that for permanent success underneath all efforts must lay a basis of sound principles on the part of those who make the goods.

In every great reform that has triumphed, sound character has been the foundation upon which the achievement has been built, and in the contest for victory over this modern evil, we see no reason for believing that this primal necessity has been removed or that it has even become obsolete.

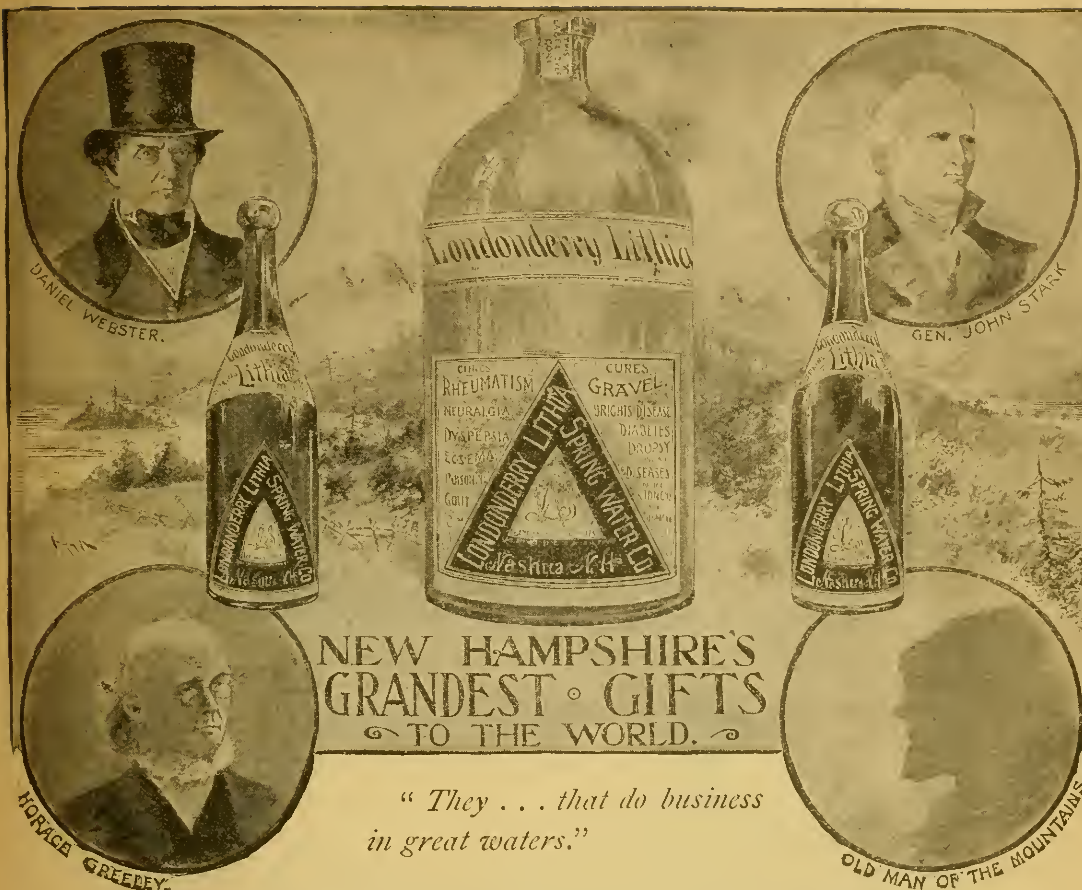
[FINIS.]

The advertisements which follow are a valuable addition to this book.

In the way of FOOD PRODUCTS, they represent only those of guaranteed reliability and soundness.

In other lines, none but strictly high-class manufacturers have been admitted.

Now let us analyze a sample of Franklin Flour of the entire wheat manufactured by the Franklin Mills Company, in Lockport, N. Y., with the best grades of white flour. The result, stripped of technicality, shows that the per cent. of water is less in the flour of the entire wheat, but the per cents. of proteids (gluten), fats and phosphates are larger than in the best white flour, while the per cent. of carbohydrates (mainly starch) remains very nearly the same.. From this it will be seen by anyone at all versed in food values, what a mistake, almost and perhaps sometimes fatal in the case of children, is made in the use of a flour for food from which the gluten and the nerve force and muscle-making portion have been removed in the process of manufacture, and the great advantage to be gained by the use of flour of entire wheat must be at once apparent. Bread from this flour is at once more palatable, more satisfying and far more sustaining than any white bread.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